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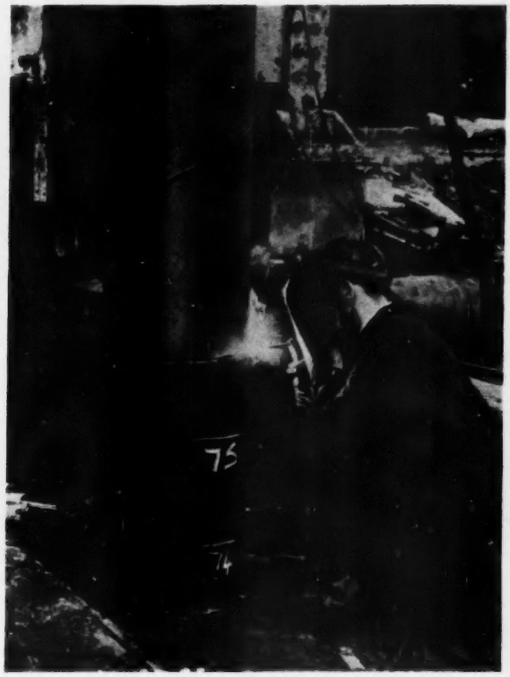

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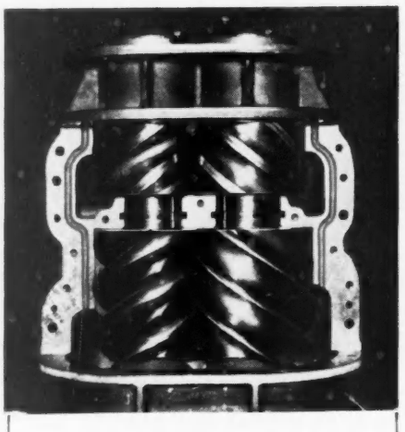

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Established 1856

No. 5403 AUGUST 14, 1959 VOL. 208

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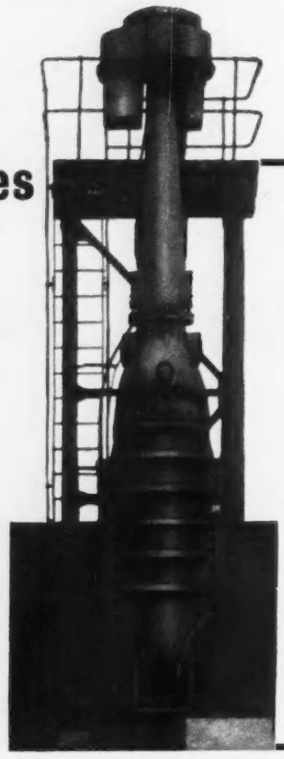

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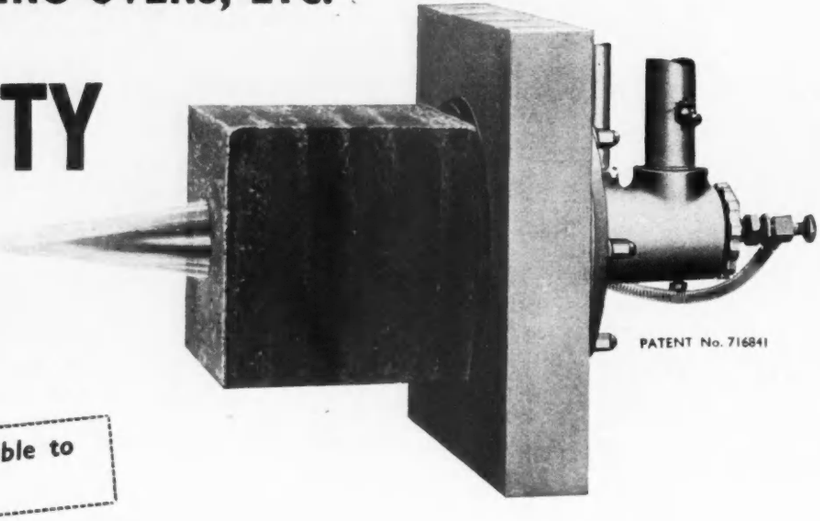

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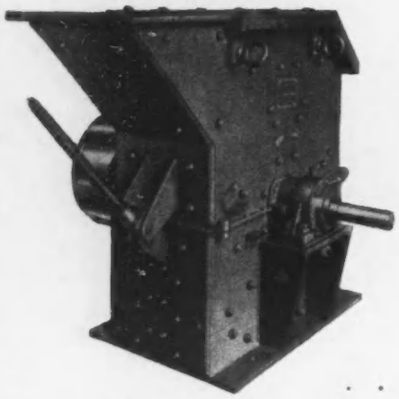

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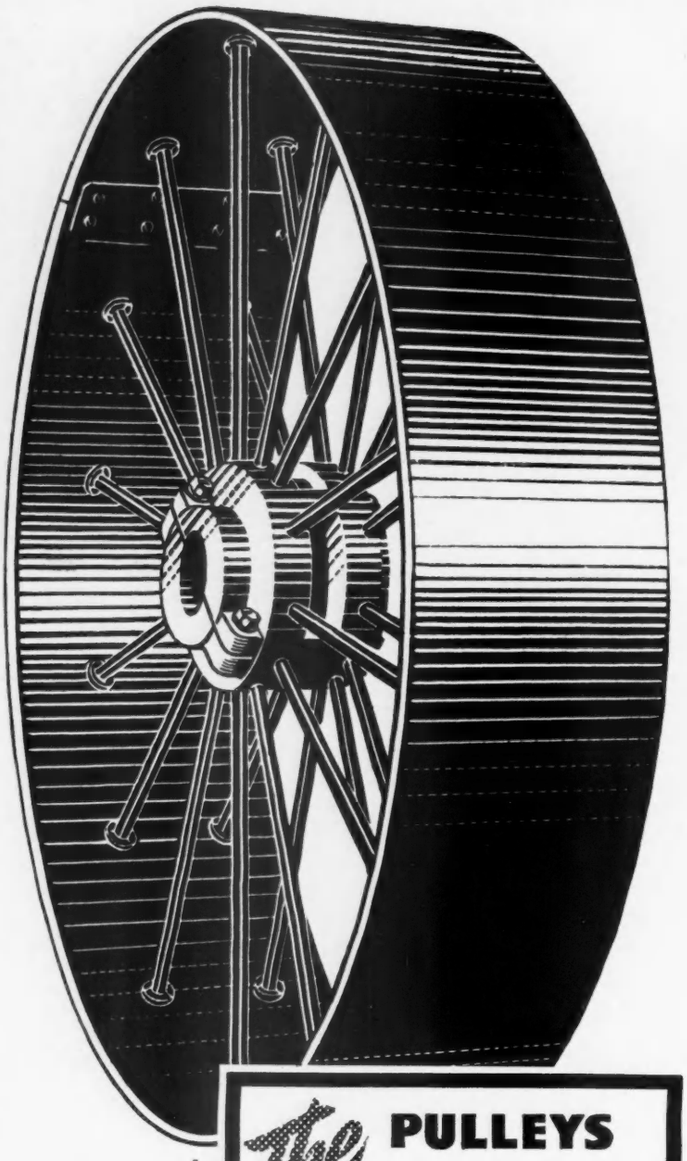

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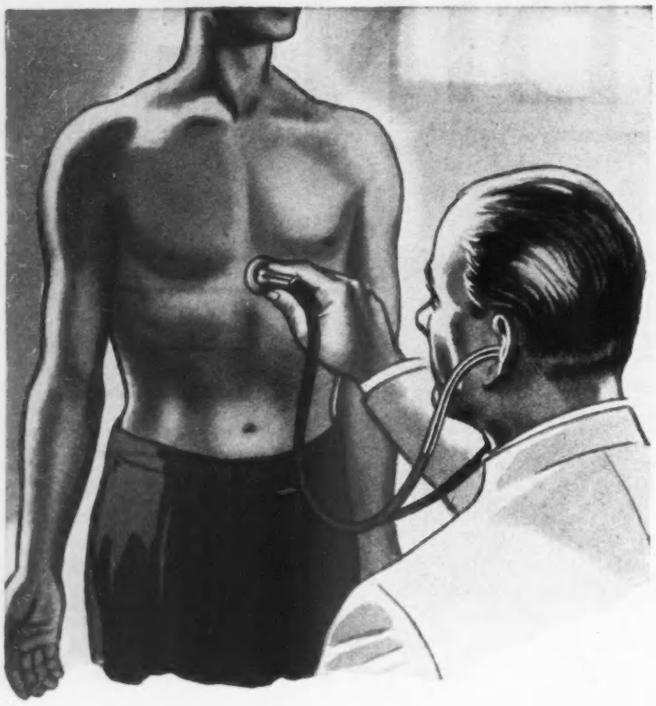

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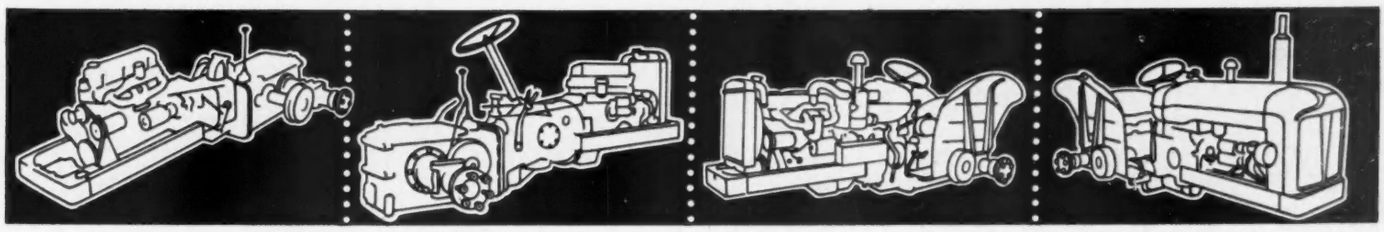

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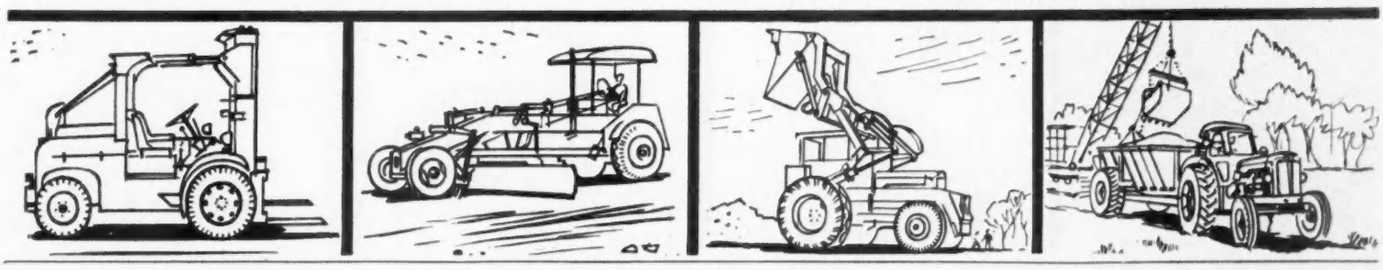

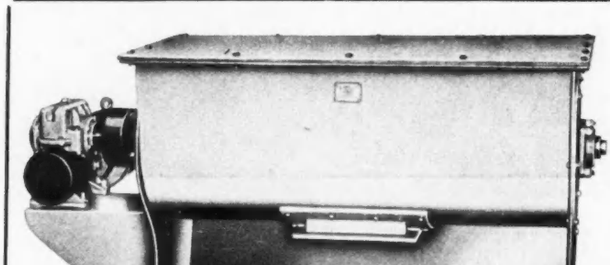

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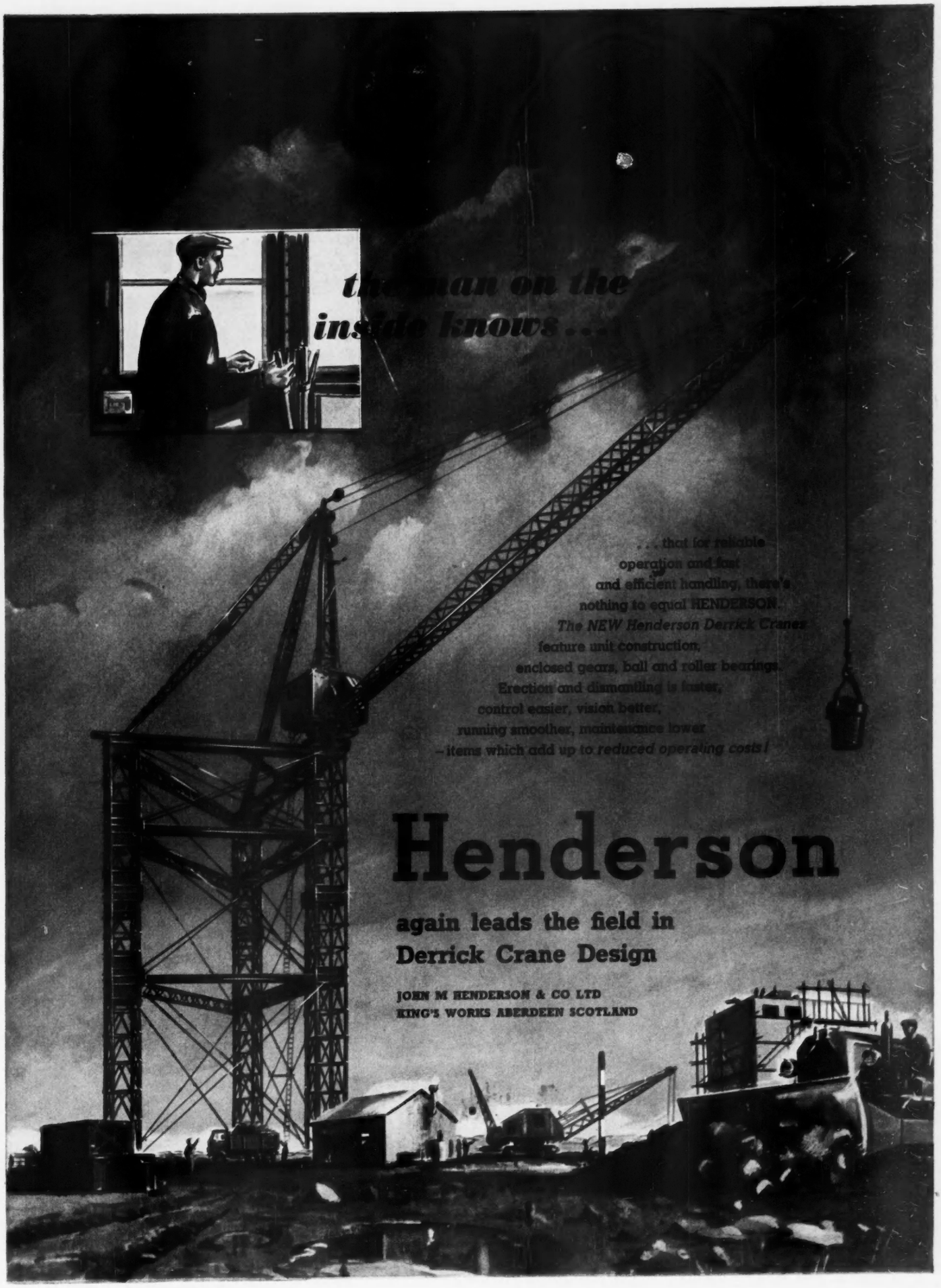
IX 22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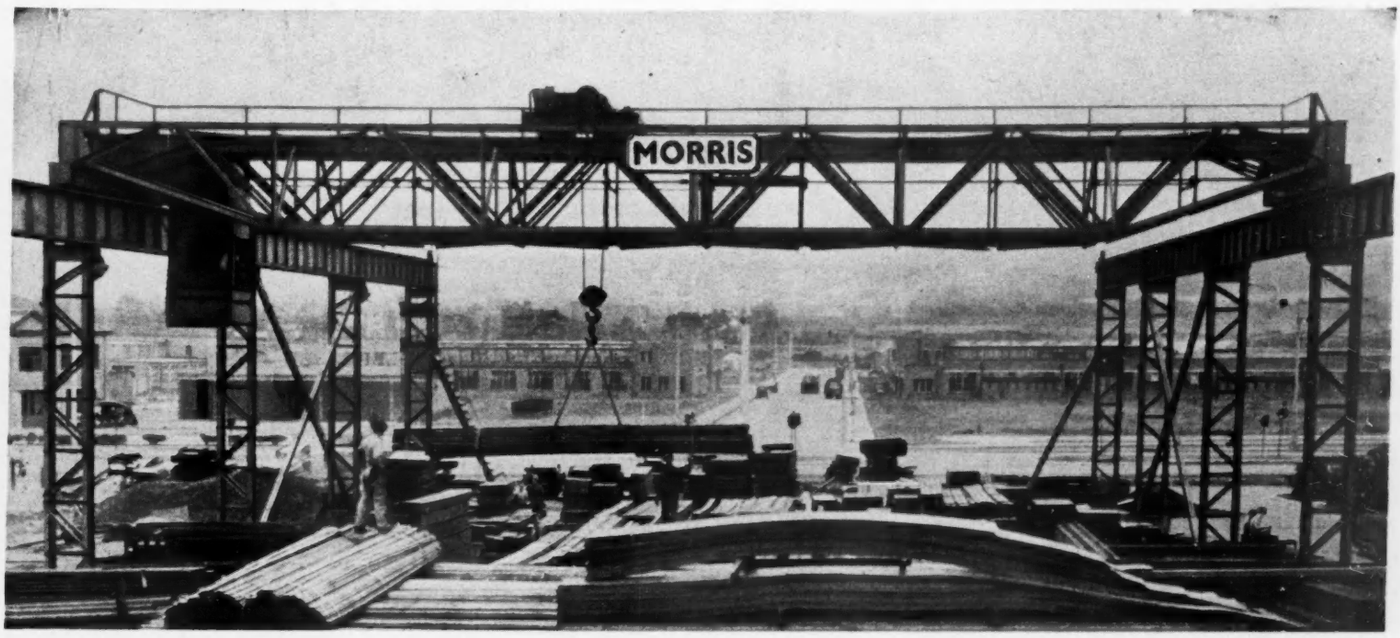

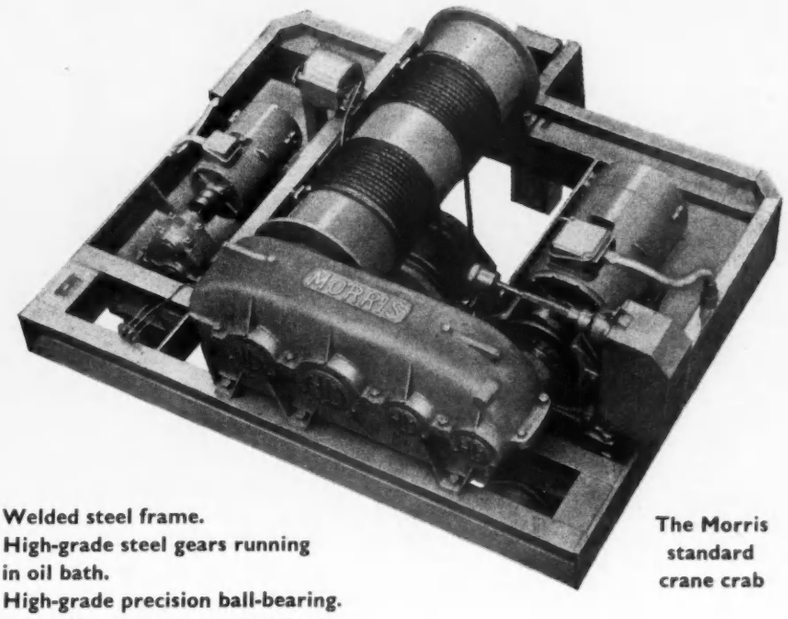

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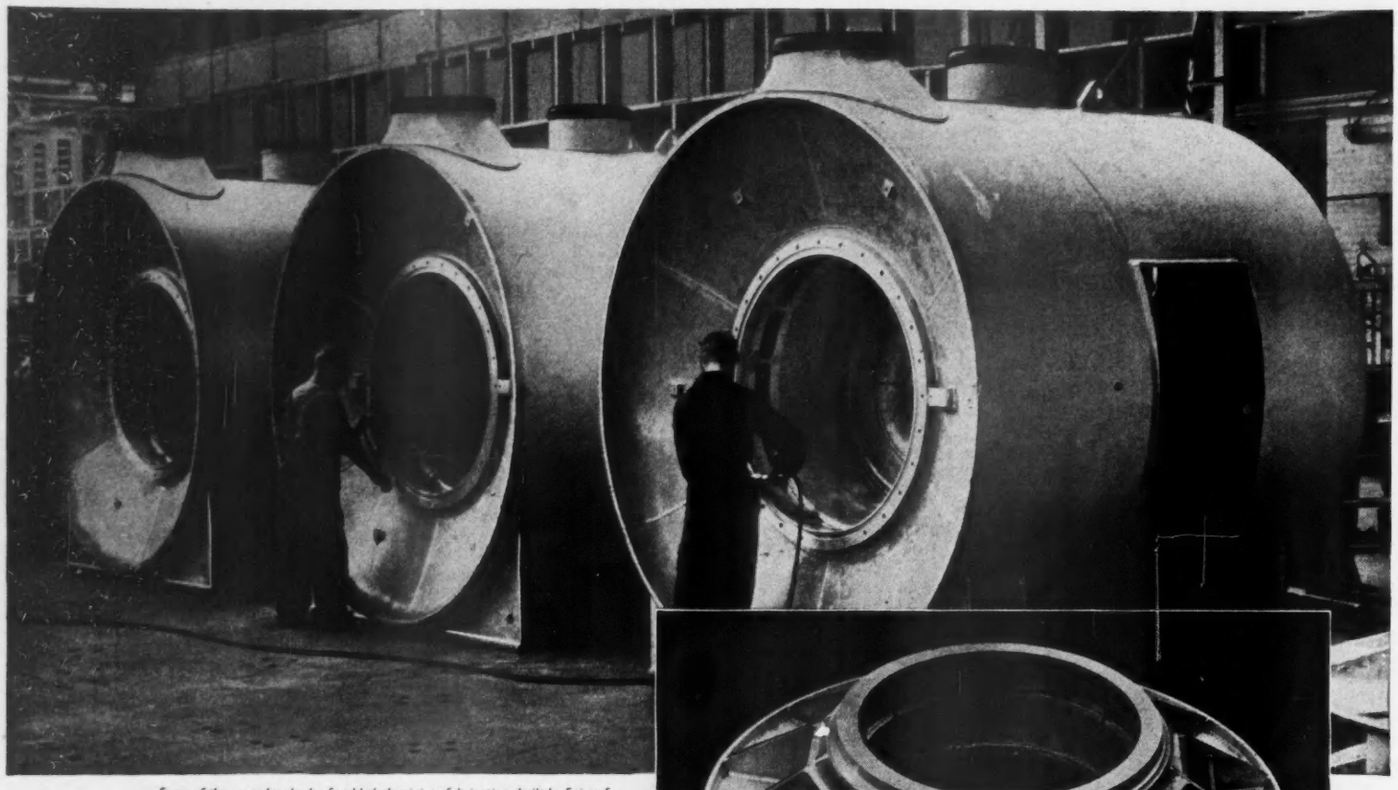

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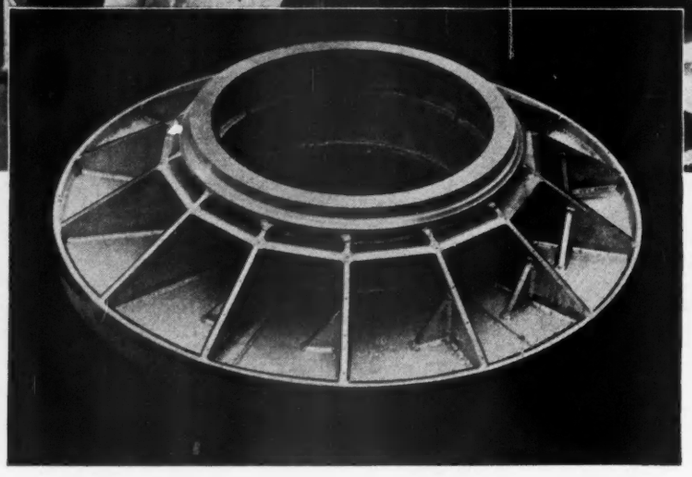

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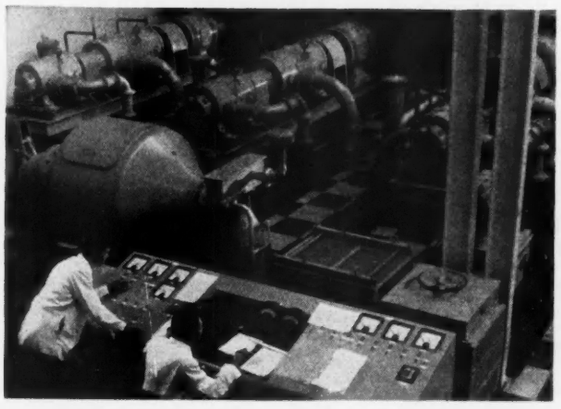

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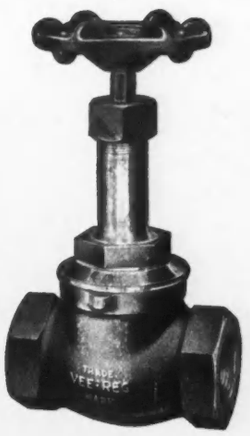

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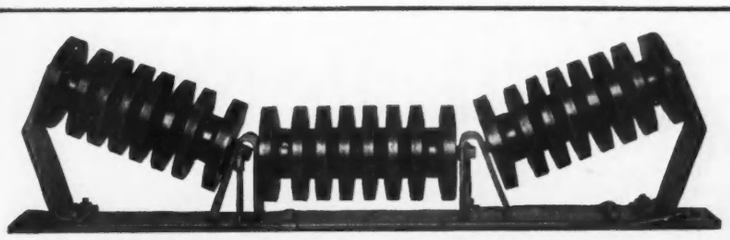

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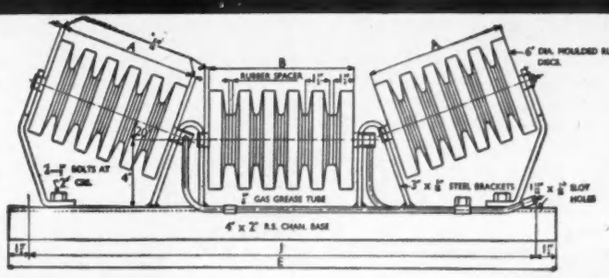
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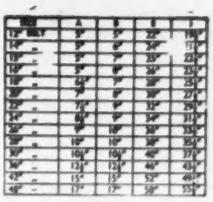

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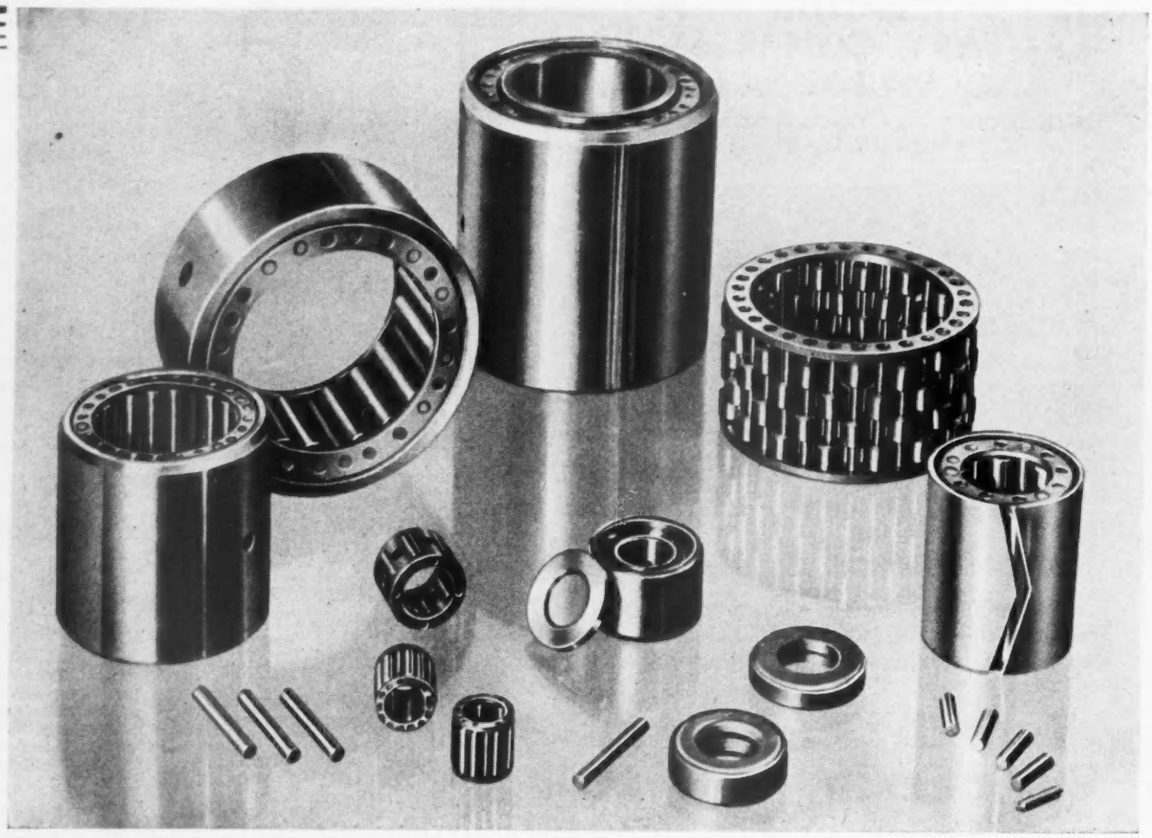

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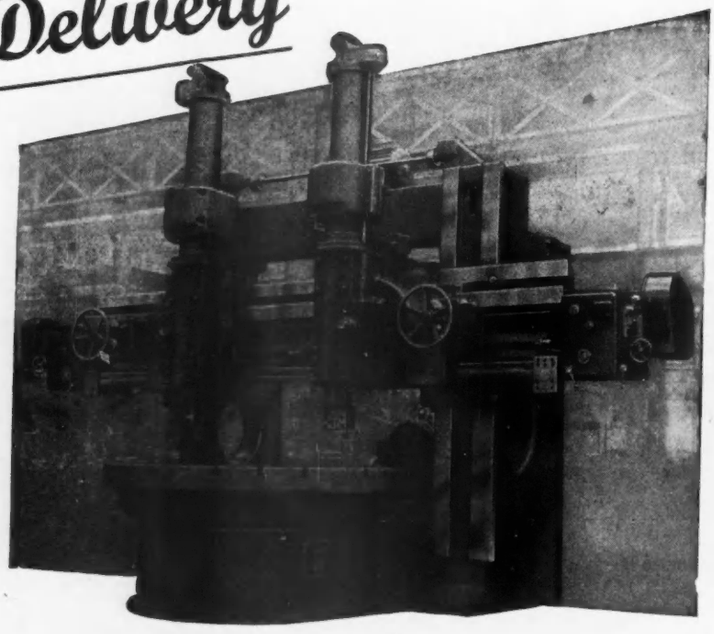

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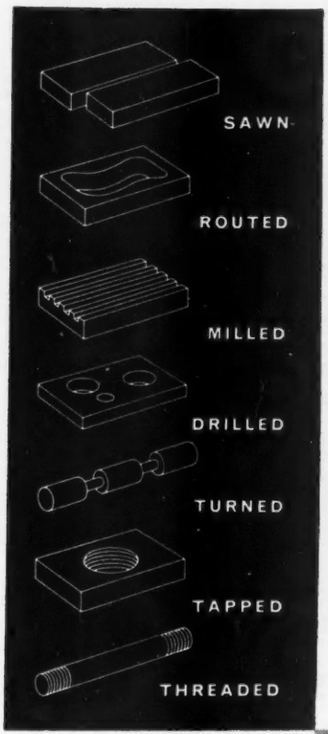

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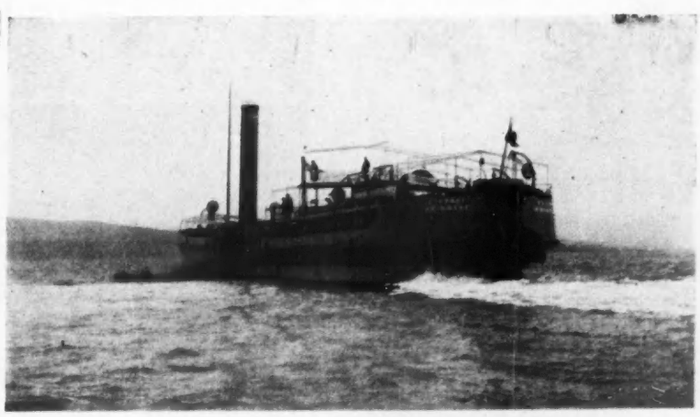

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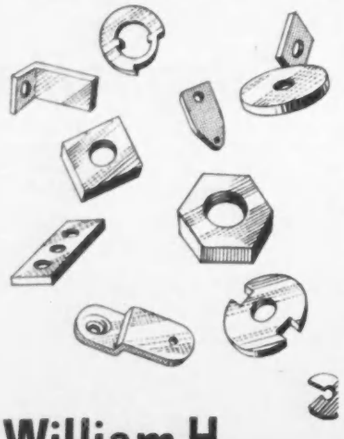

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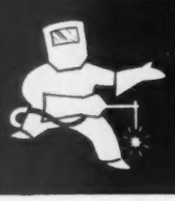

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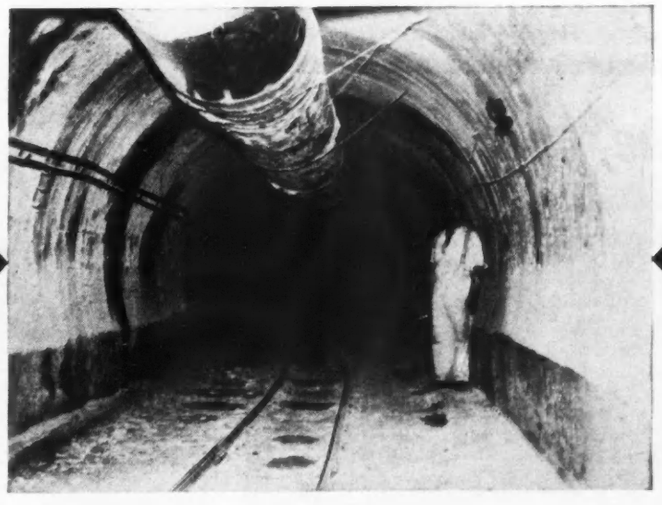

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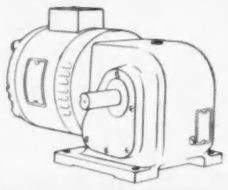

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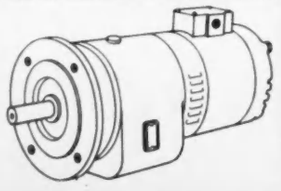

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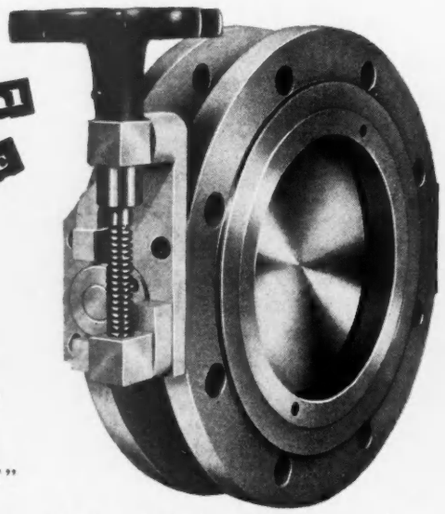

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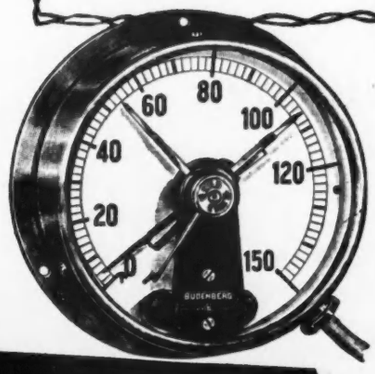

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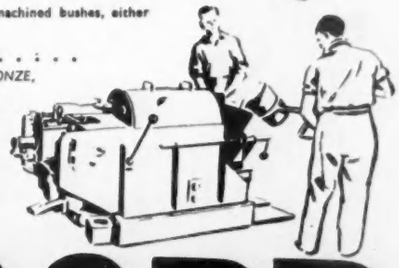

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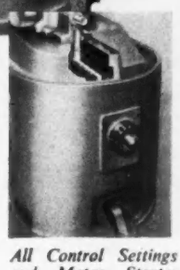

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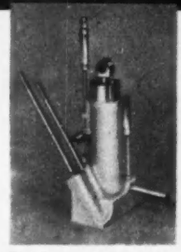

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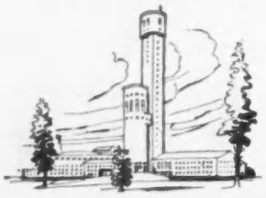

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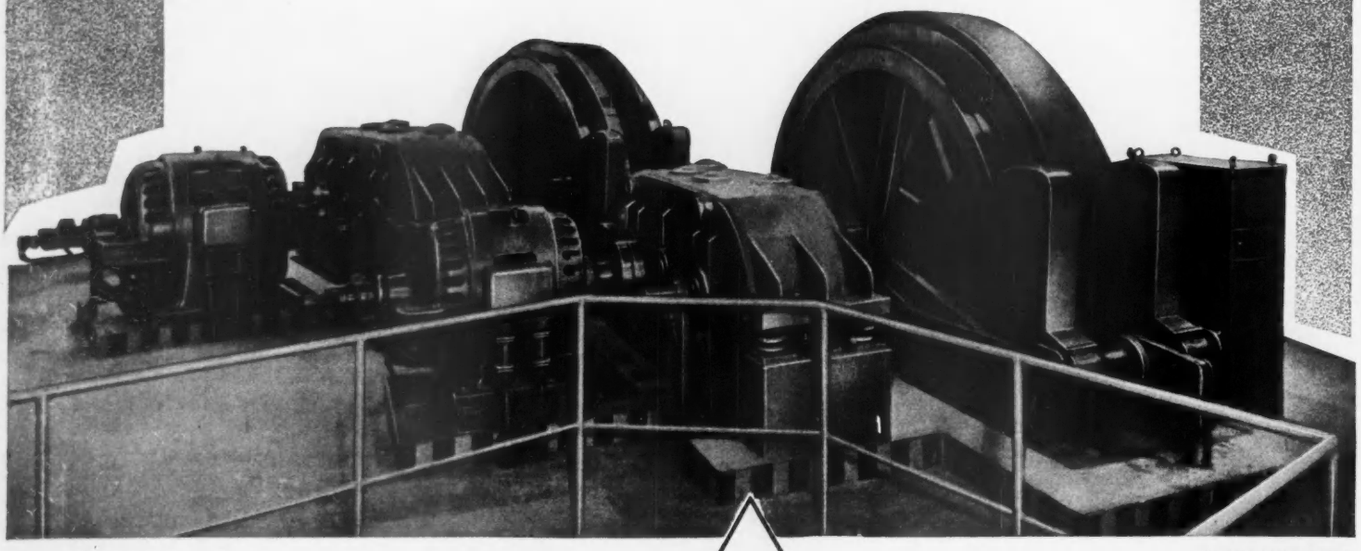

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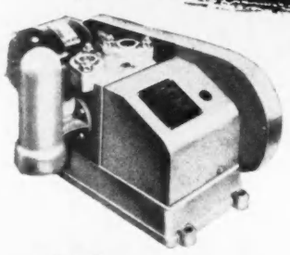

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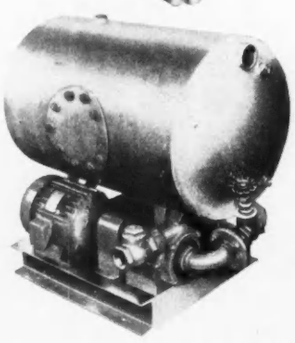

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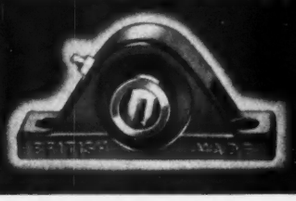

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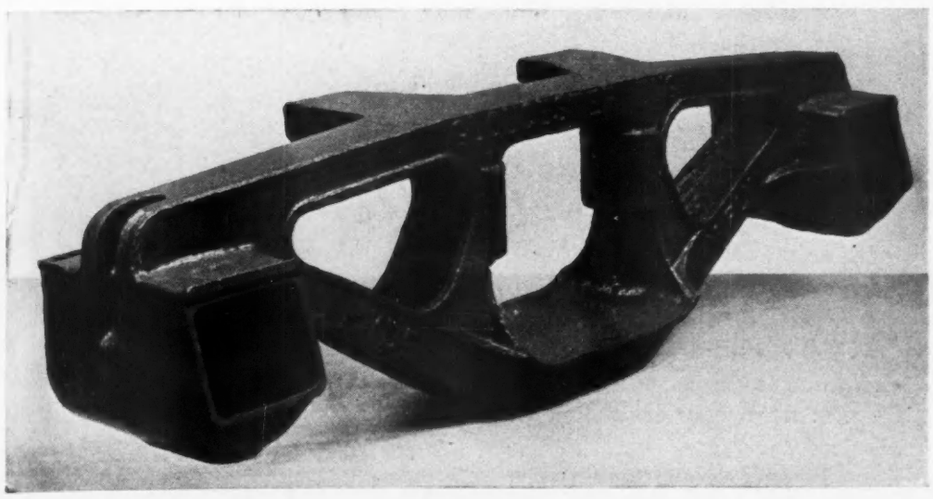

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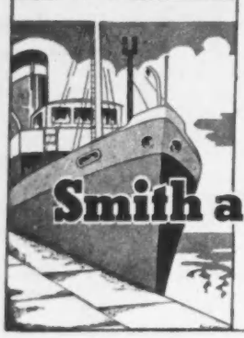

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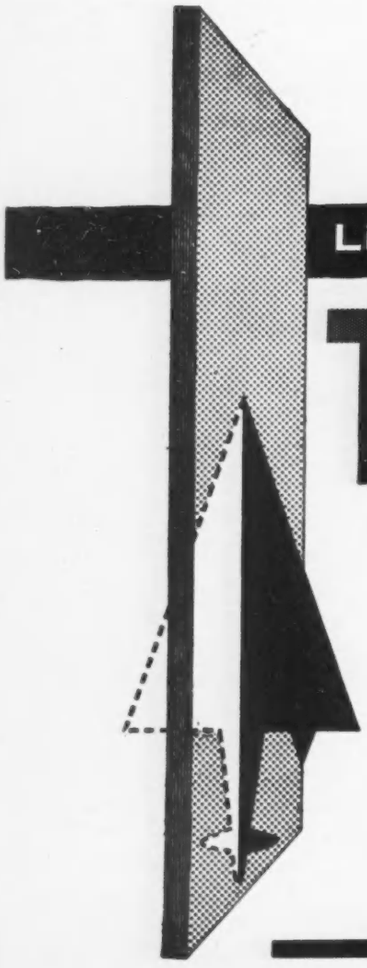

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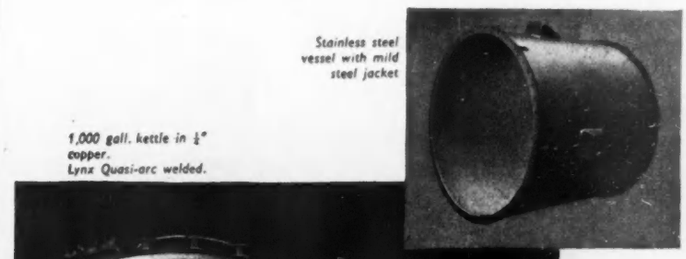

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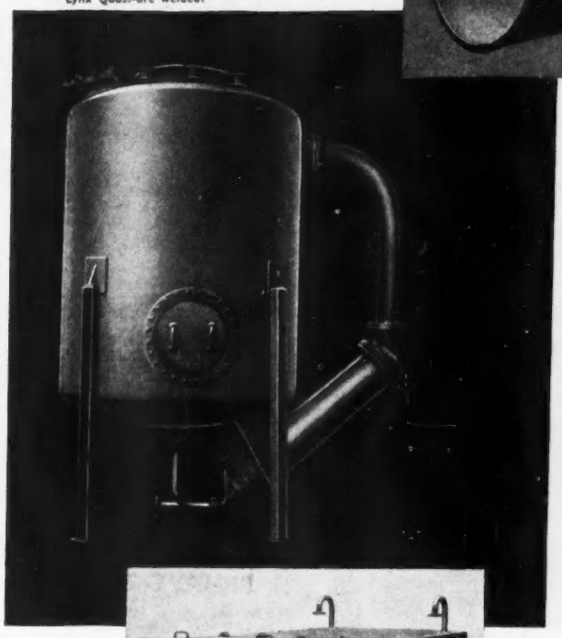

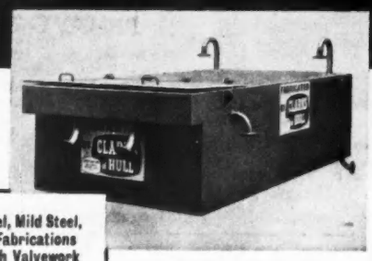

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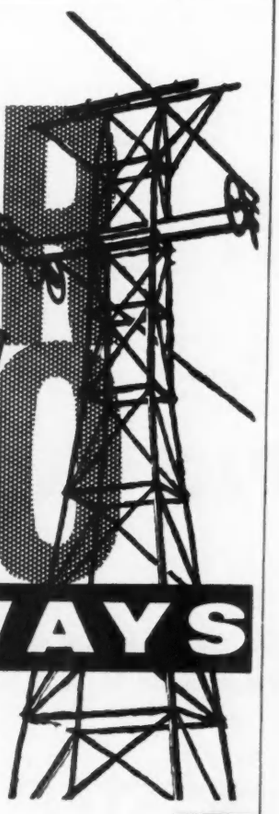

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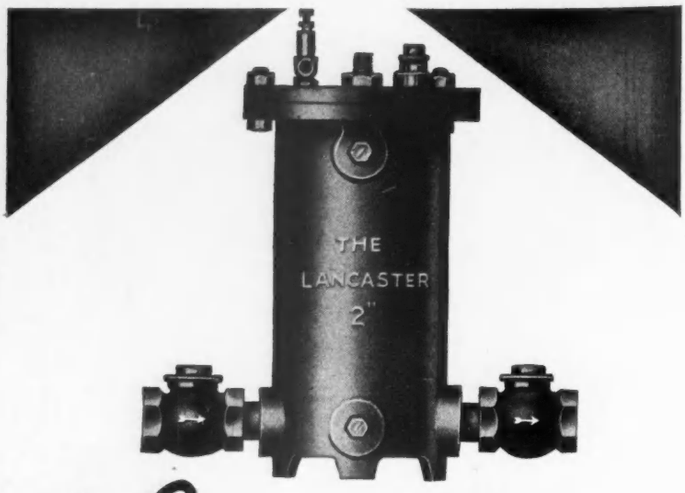

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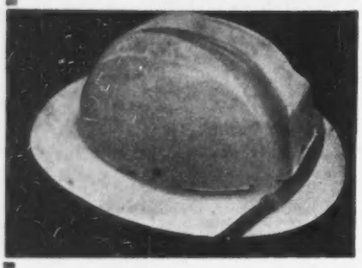

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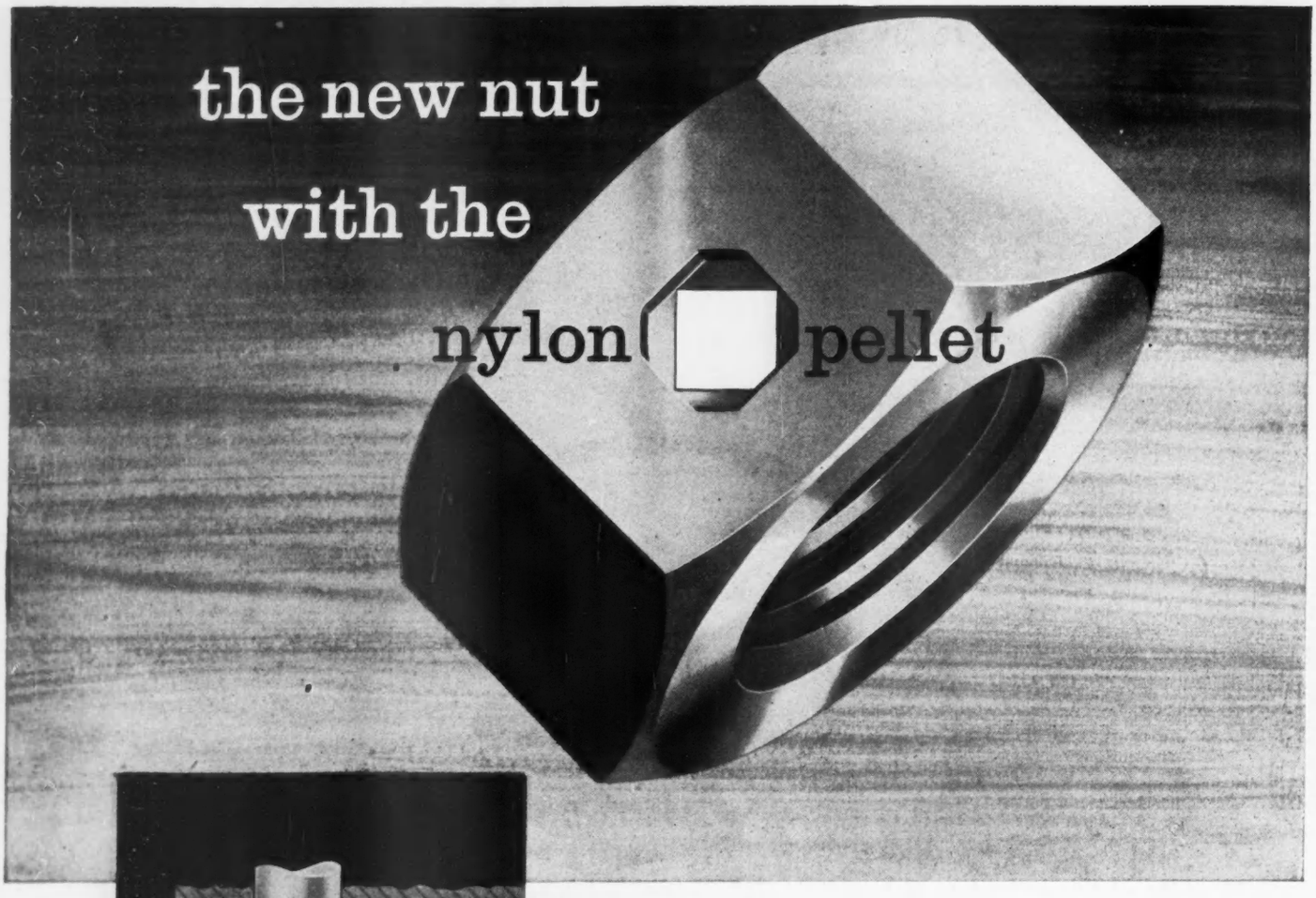

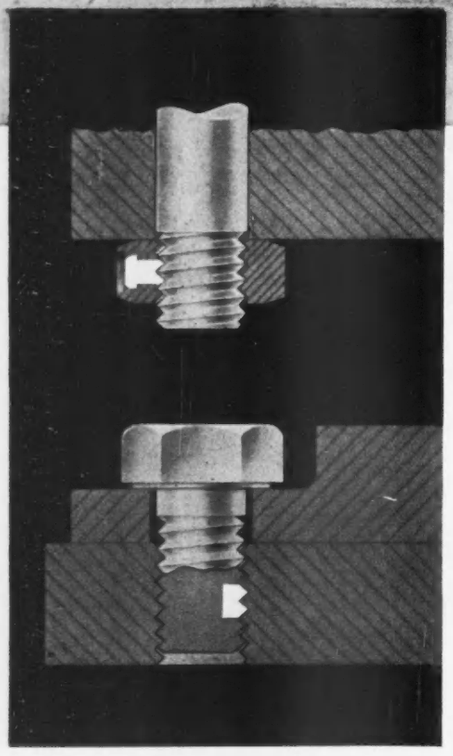

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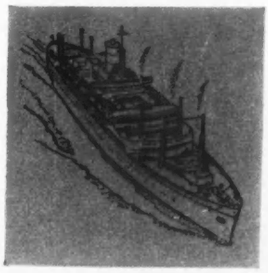

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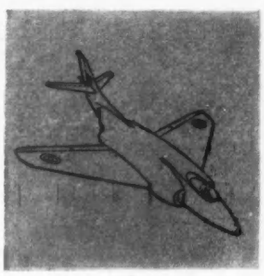
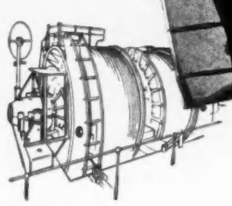
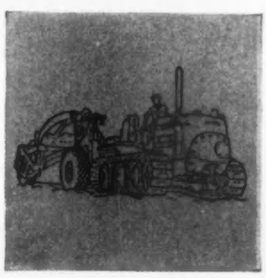
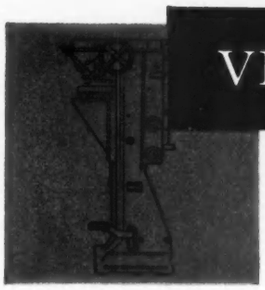






Power station plant designed and constructed by Vickers-Armstrongs is noted for its efficiency and dependability. The range of equipment includes condensers, feed heaters, de-aereators, evaporating plant and circulating water pumps. In the last few years, the contracts received by the company for this type of plant from the Central Electricity Authority and from overseas organisations involve power stations whose total output is nearly 3,000,000 kW.



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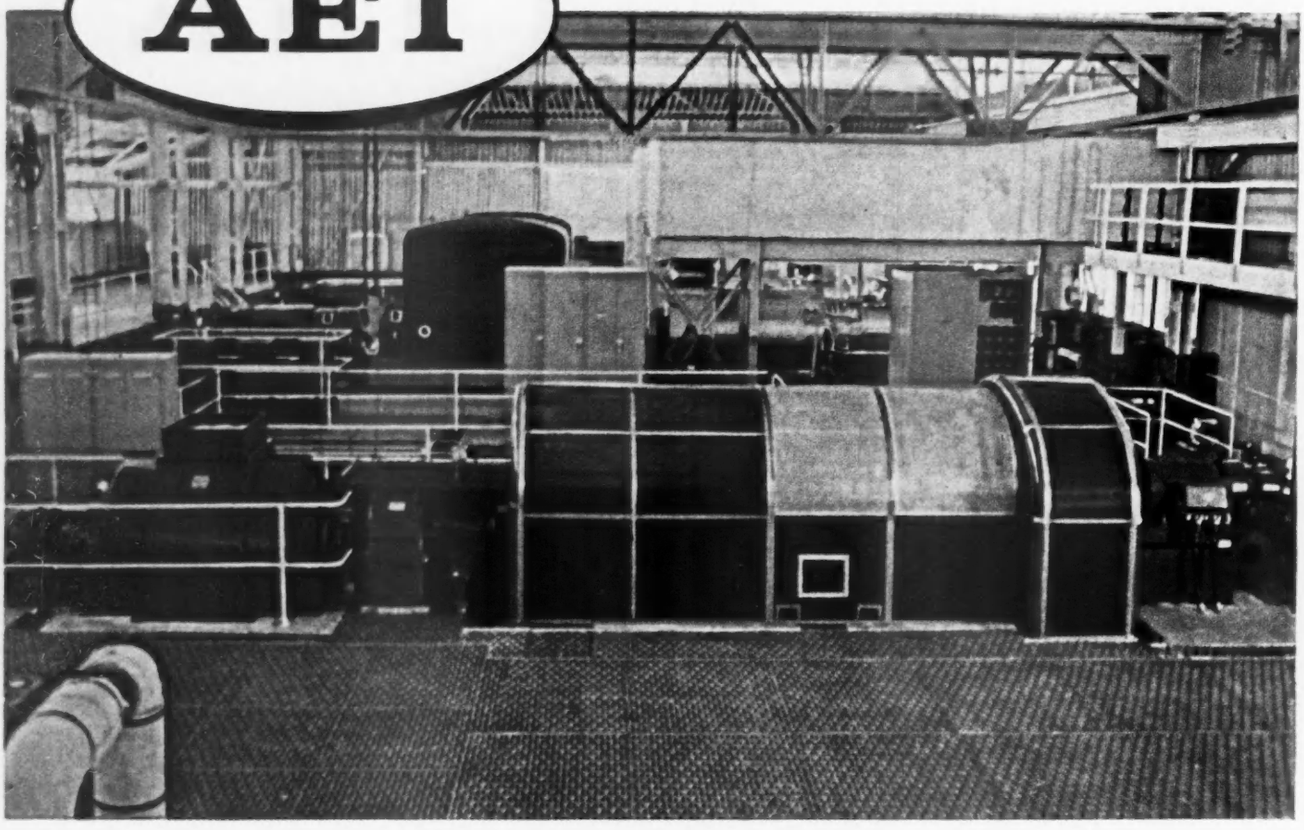

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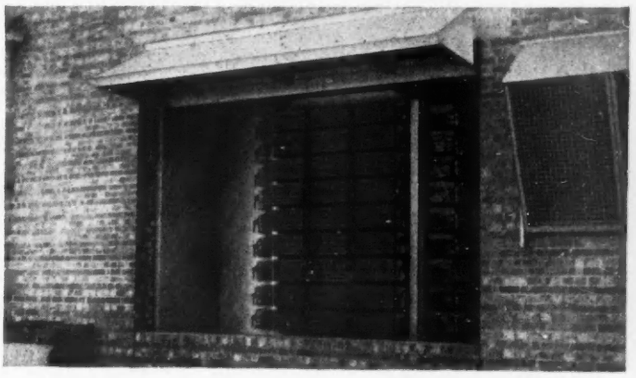
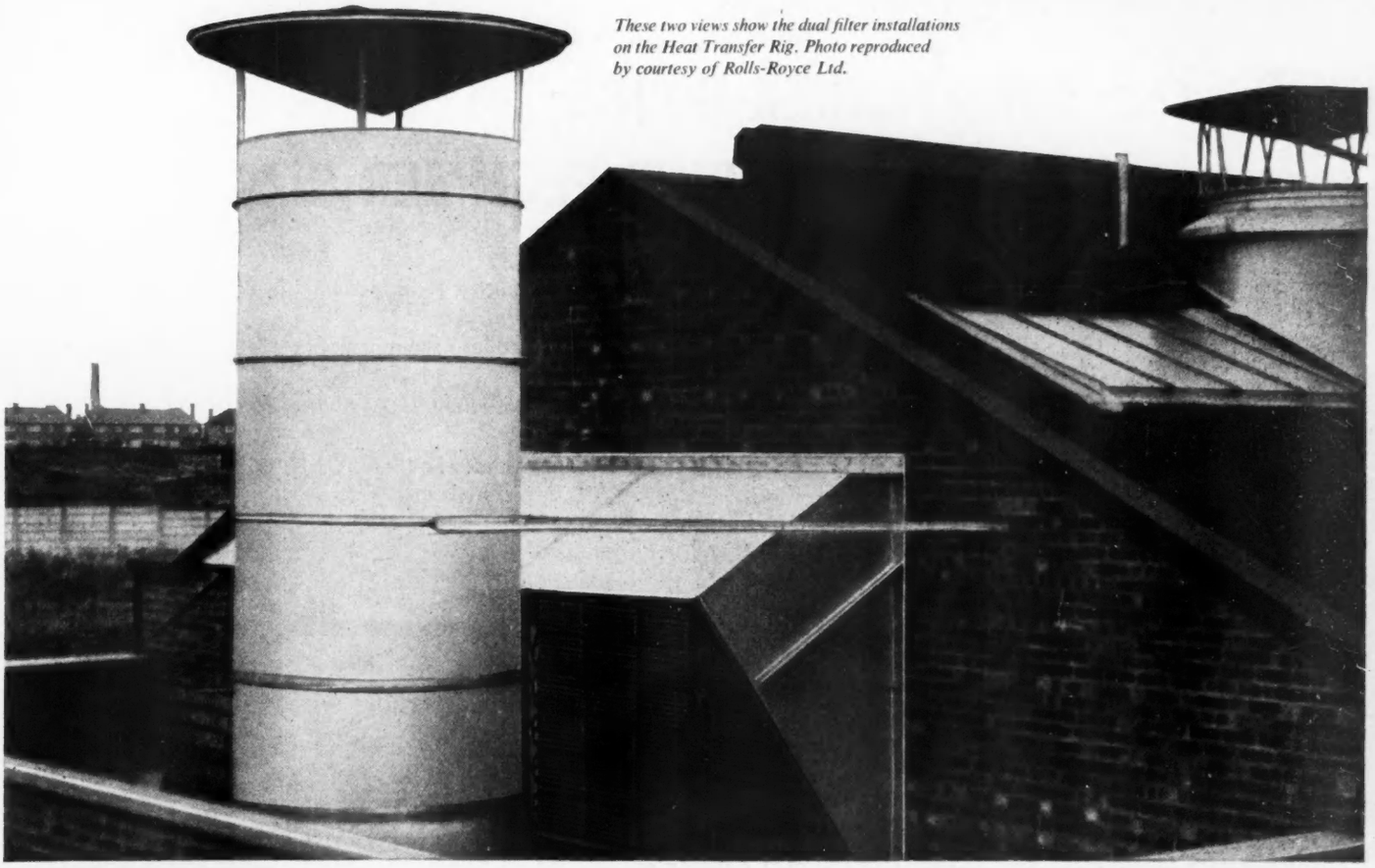


*** When specifying your filtration requirements, we strongly recommend that you request test information against B.S.S. 2831.**

These two views show the dual filter installations on the Heat Transfer Rig. Photo reproduced by courtesy of Rolls-Royce Ltd.



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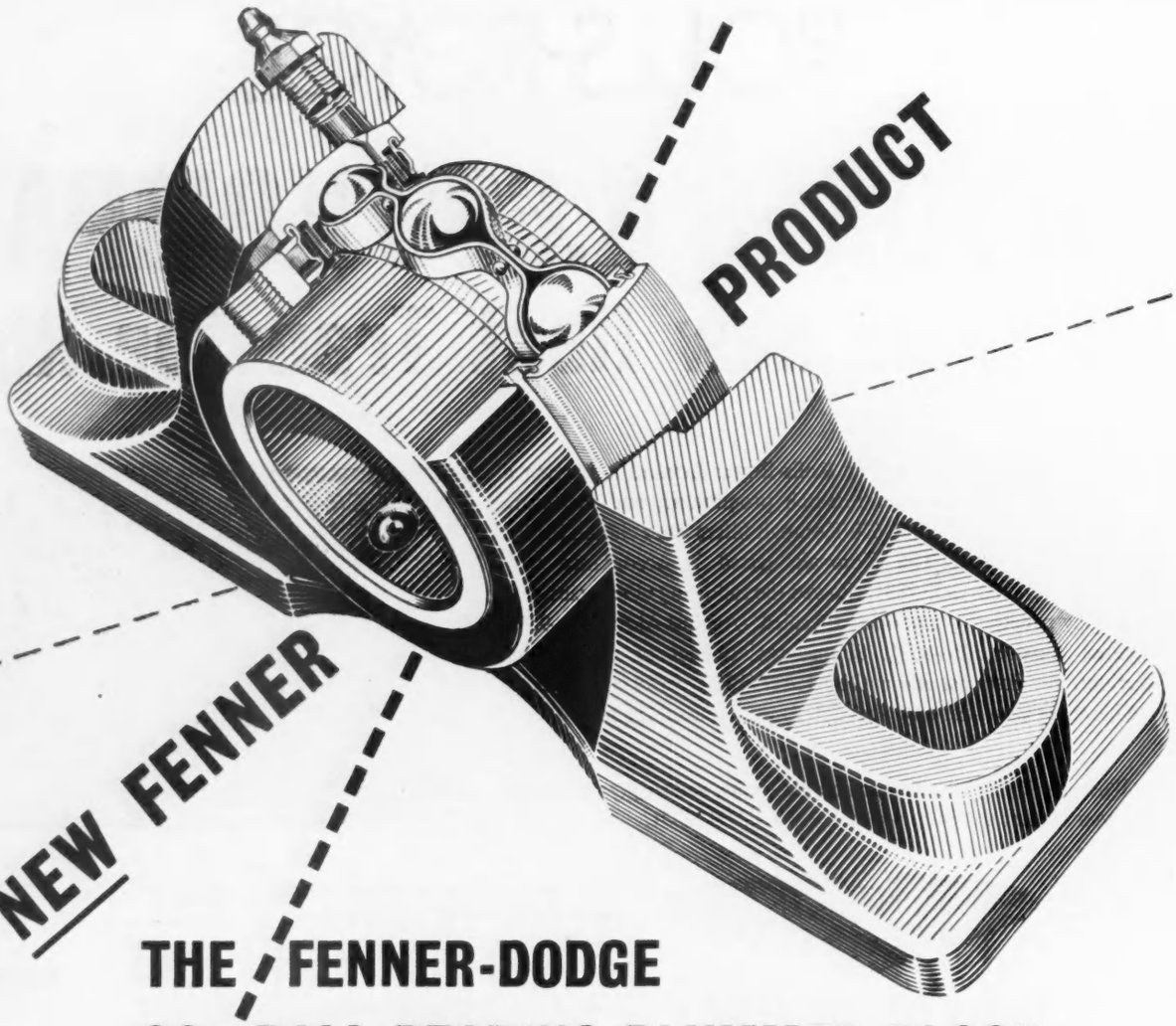

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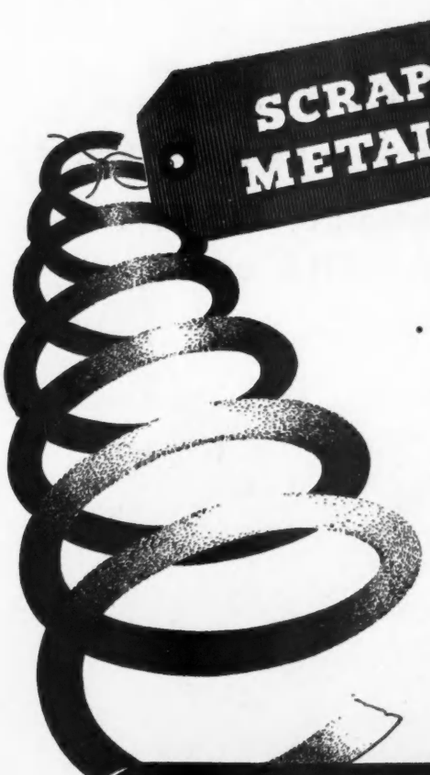

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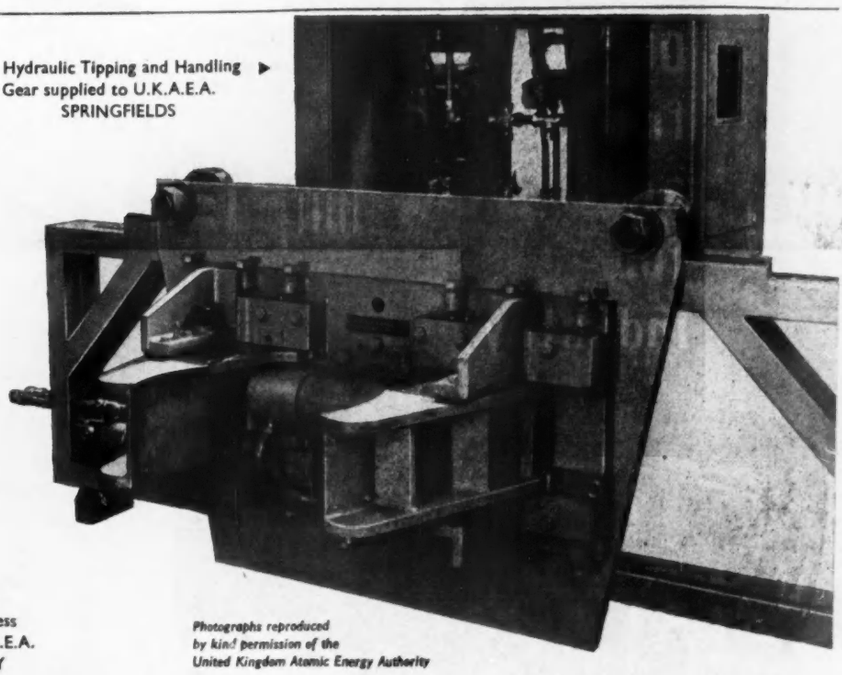

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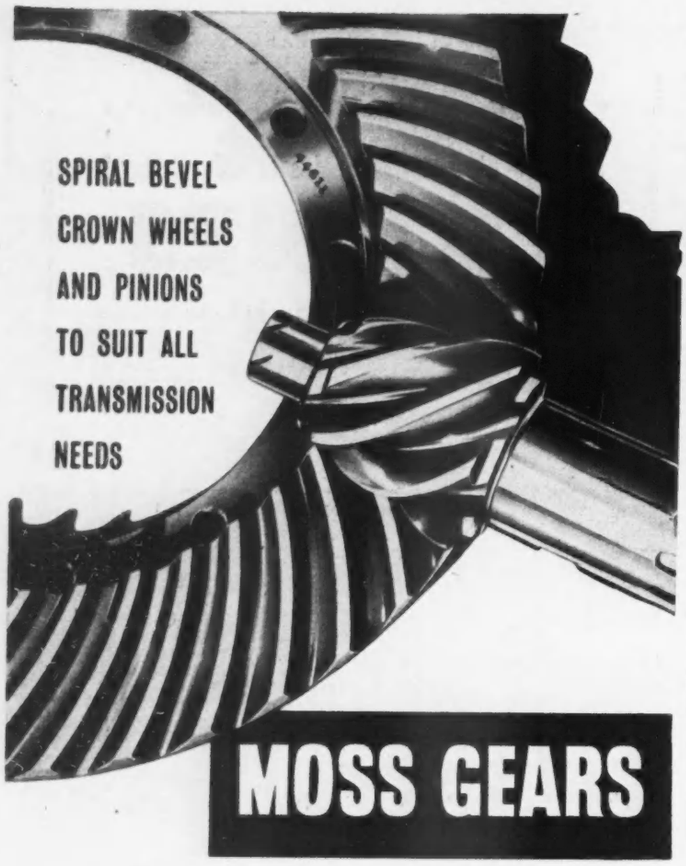

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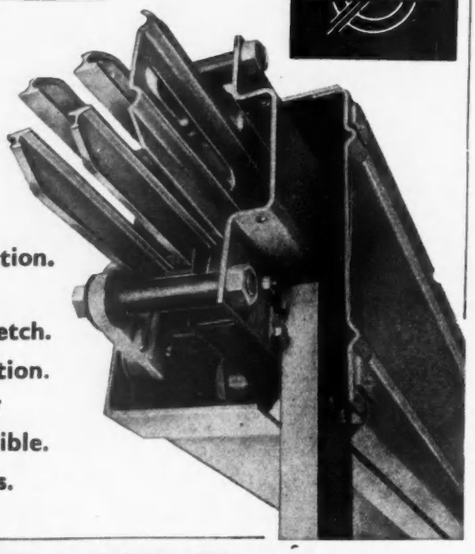

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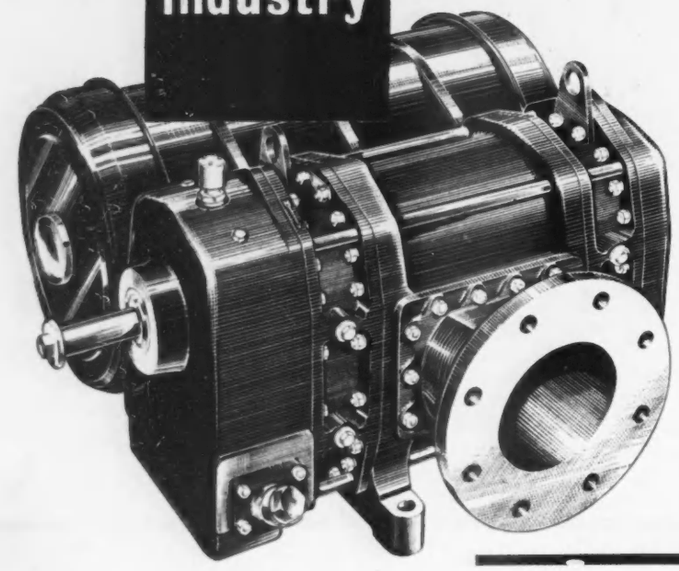

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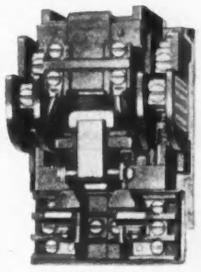

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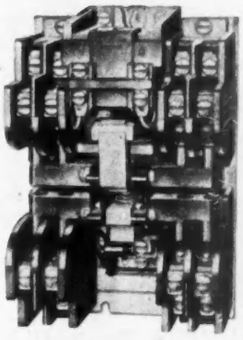

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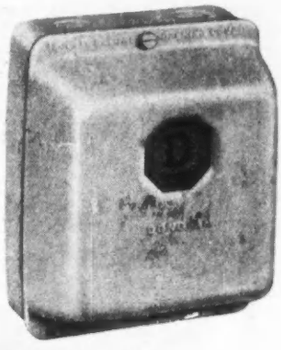

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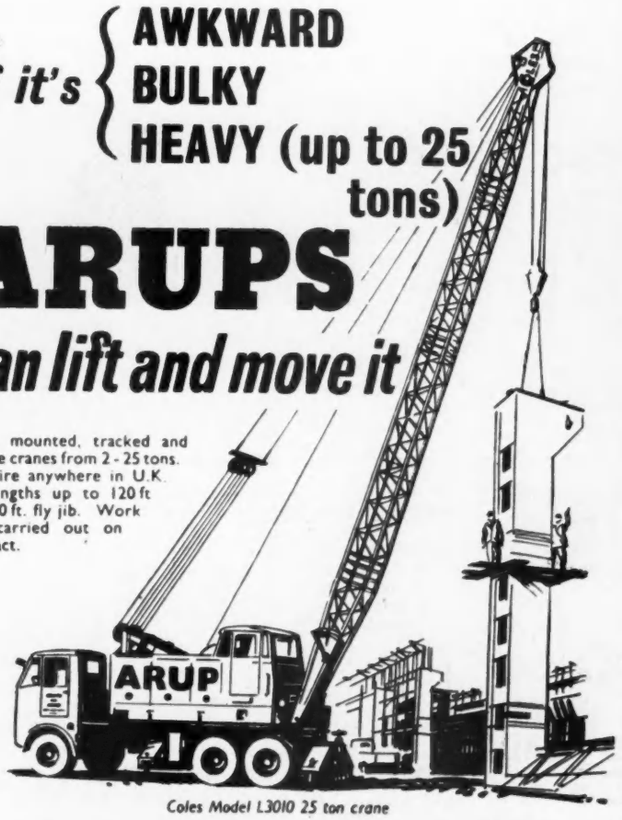

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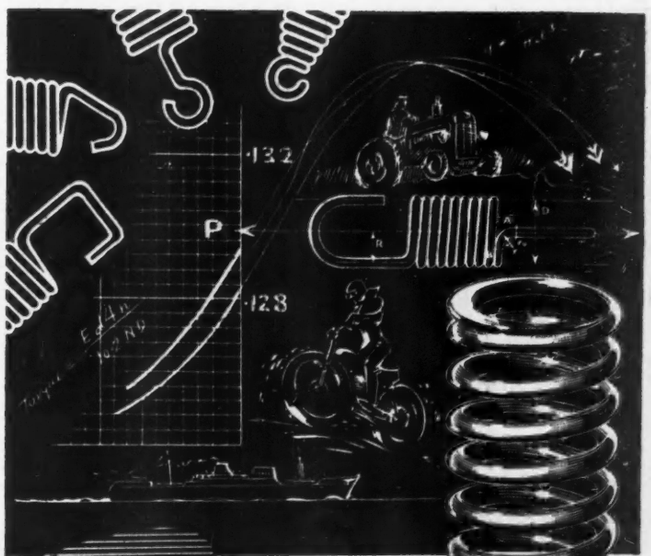

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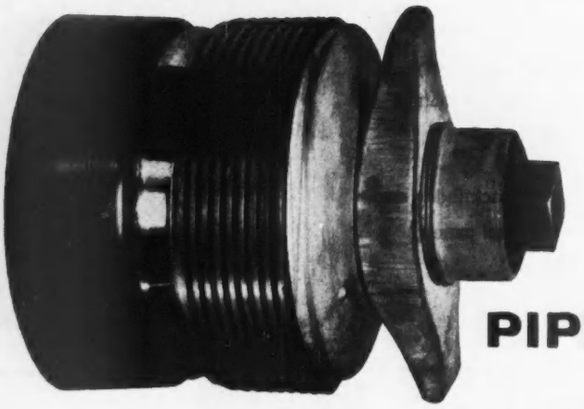

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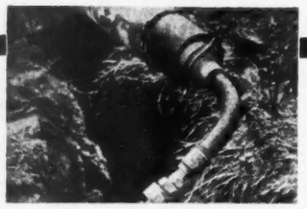
The higher the pressure, the tighter the stopper

Pressure testing of open-ended steel pipes and pipe fittings is considerably simplified with the aid of cone lock pipe stoppers. These tools are designed to withstand test pressures of up to 200 lbs./sq. in. and can be used successfully for any application where a simple, efficient and re-usable seal is required. For further details, ask for our leaflet "Cone Lock Pipe Stoppers."



The cone lock pipe stopper in position.

The stopper is easily removed after testing by slackening the wing nut.

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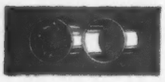

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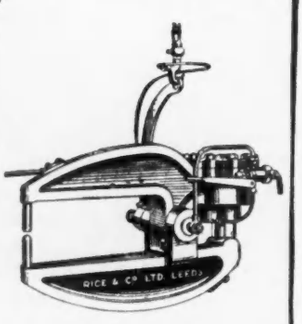

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Sinister rumours cloud the memory of the Giant of Trebiggan. But with those enormous arms of his — and the robust humour that was fashionable in his day — temptation must have been great. If he did sometimes restore his giant's strength with a fat baby for breakfast, the sailors he snatched from ships struggling past Lands End weren't always treated so summarily. After enjoying his joke to the full, he would occasionally put one back again . . .

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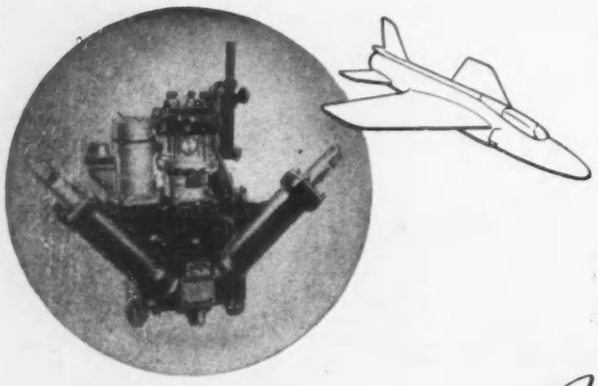

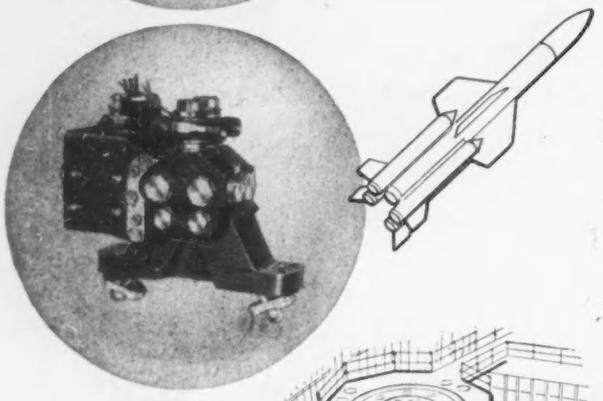

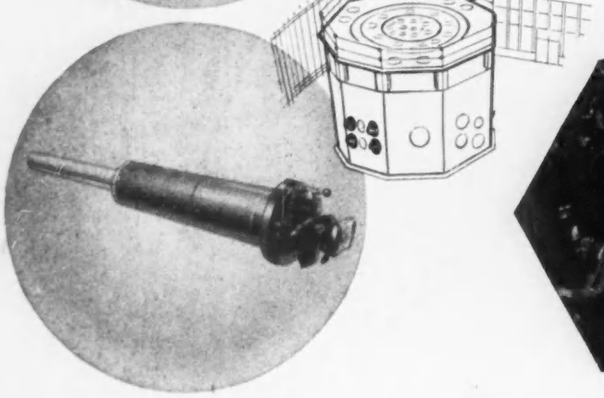

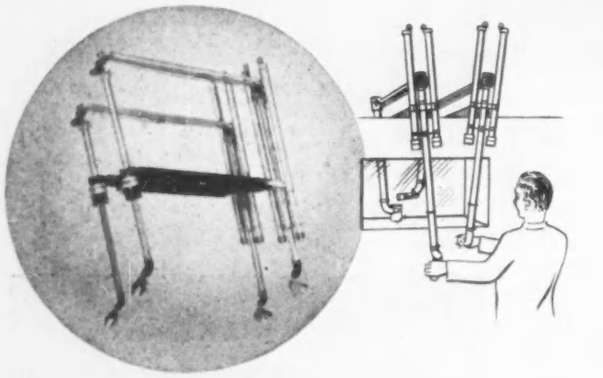

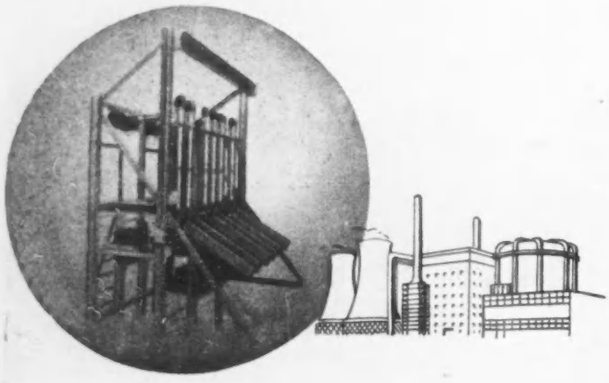

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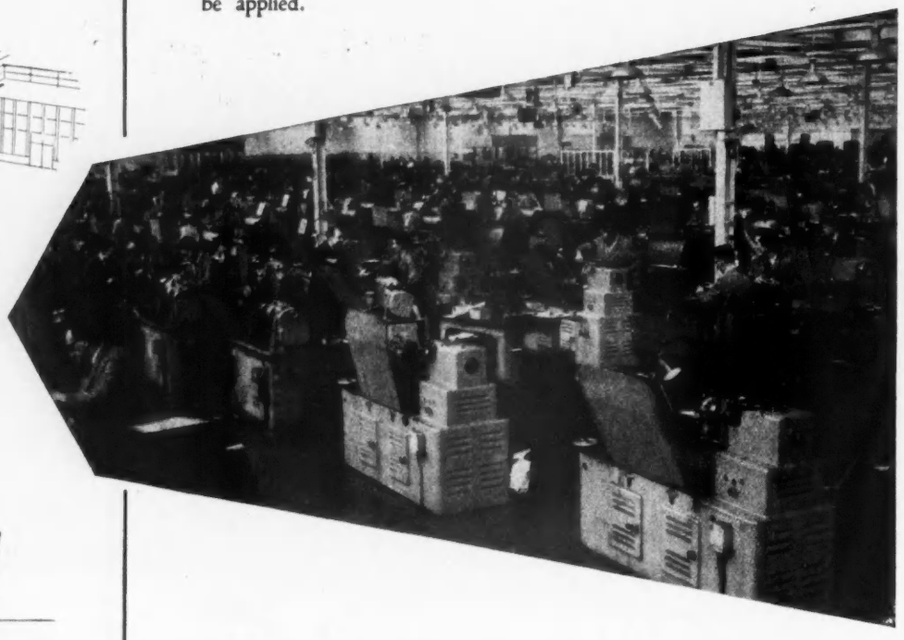

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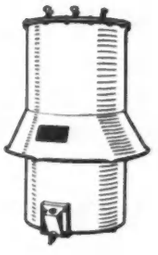

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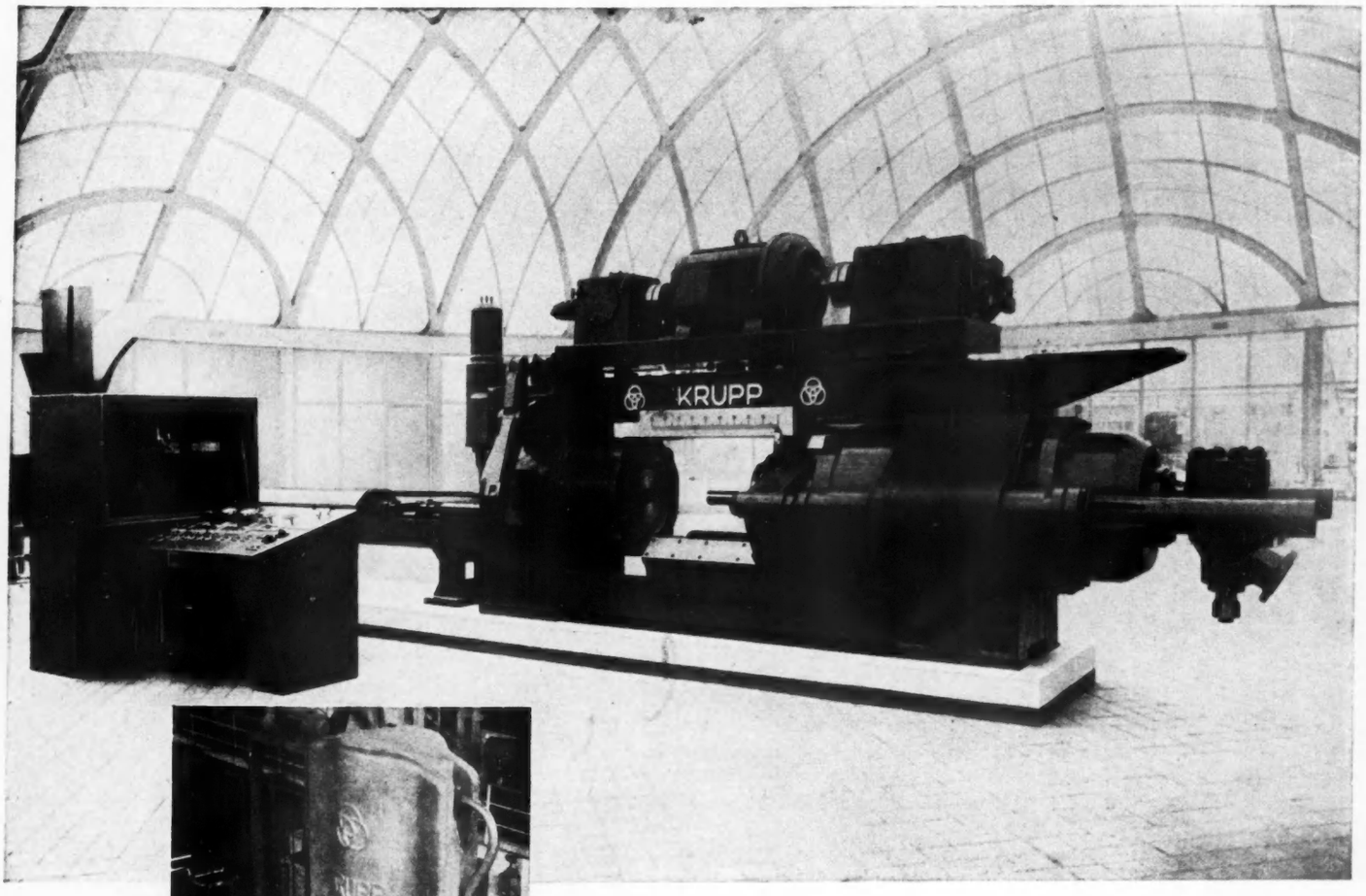

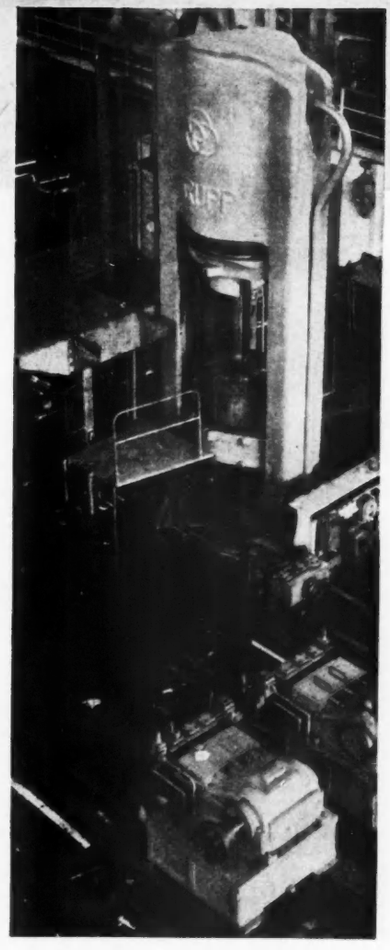

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JOHN THOMPSON (TRIUMPH STOKER) LTD., KIRKSTALL ROAD, LEEDS 3

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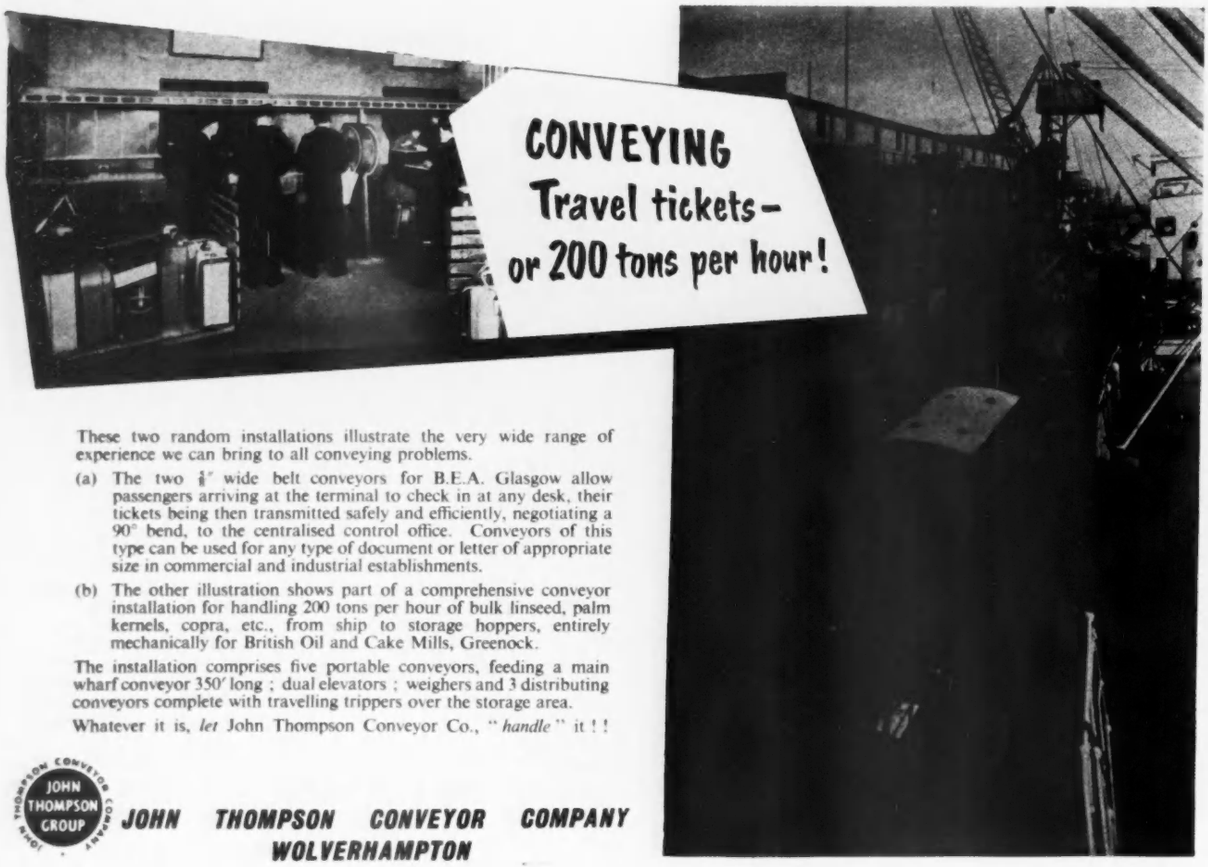

These two random installations illustrate the very wide range of experience we can bring to all conveying problems.

(a) The two $\frac{1}{2}$" wide belt conveyors for B.E.A. Glasgow allow passengers arriving at the terminal to check in at any desk, their tickets being then transmitted safely and efficiently, negotiating a 90° bend, to the centralised control office. Conveyors of this type can be used for any type of document or letter of appropriate size in commercial and industrial establishments.

(b) The other illustration shows part of a comprehensive conveyor installation for handling 200 tons per hour of bulk linseed, palm kernels, copra, etc., from ship to storage hoppers, entirely mechanically for British Oil and Cake Mills, Greenock.

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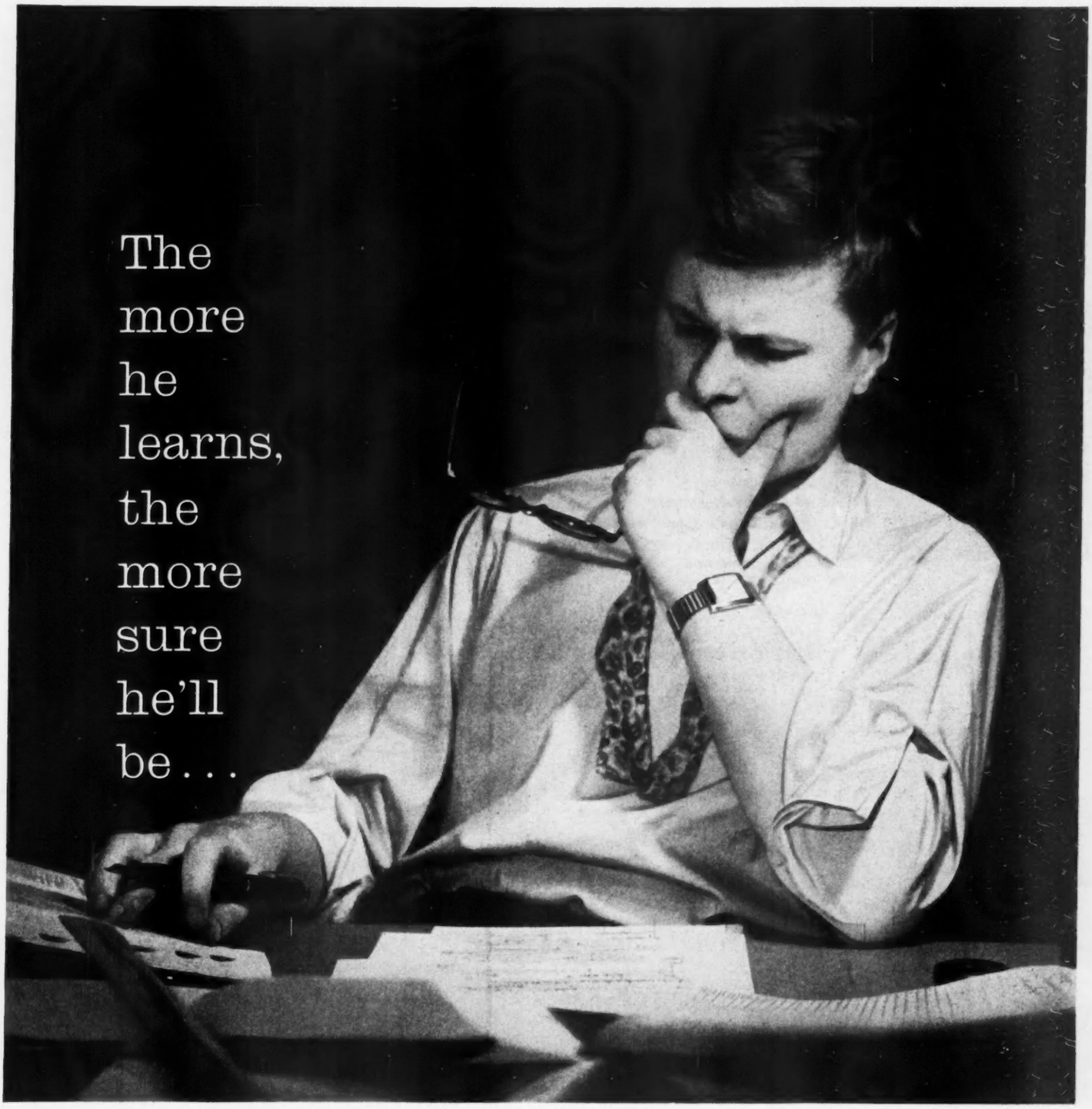

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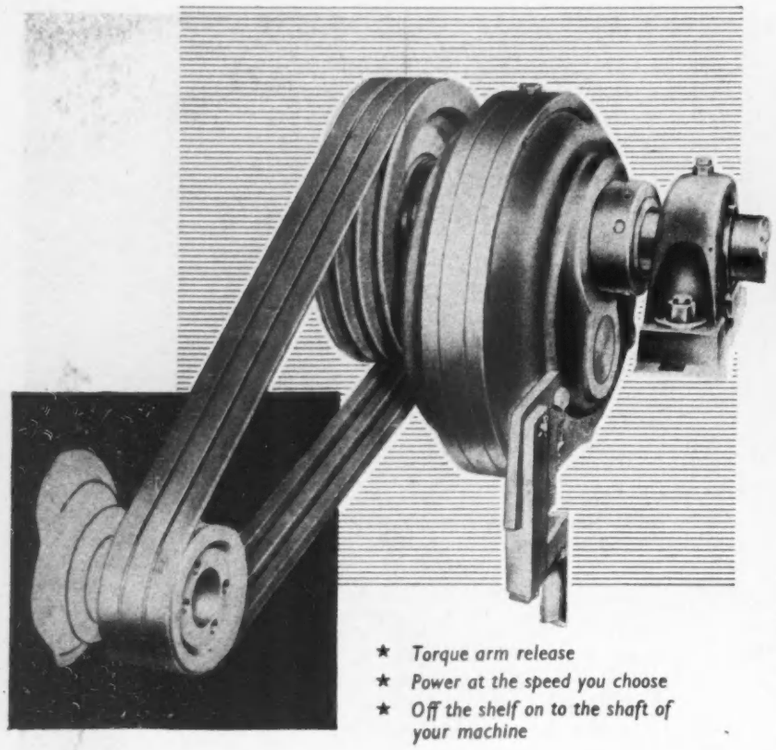

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Shaft-Kings are space saving, economical, easy to select and easy to instal. Please write for further particulars.

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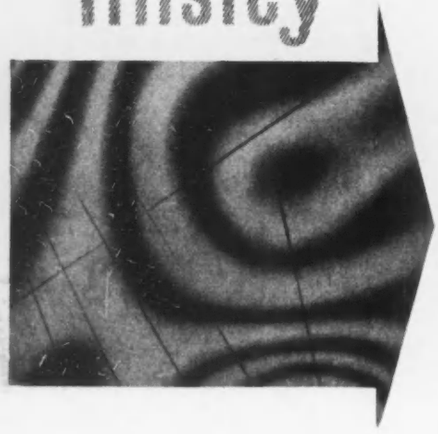

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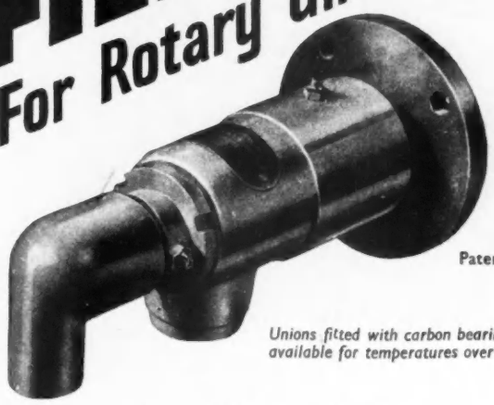

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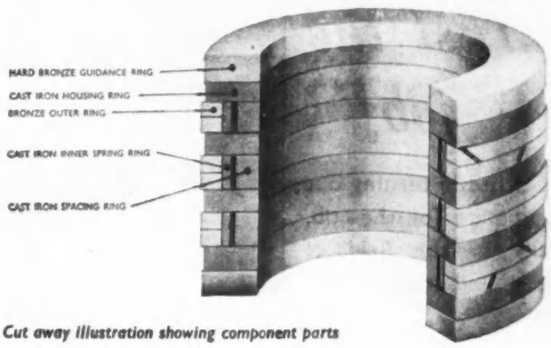

Cut away illustration showing component parts

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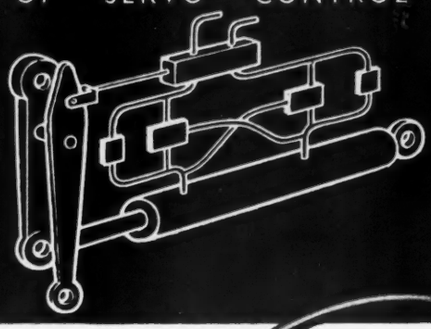

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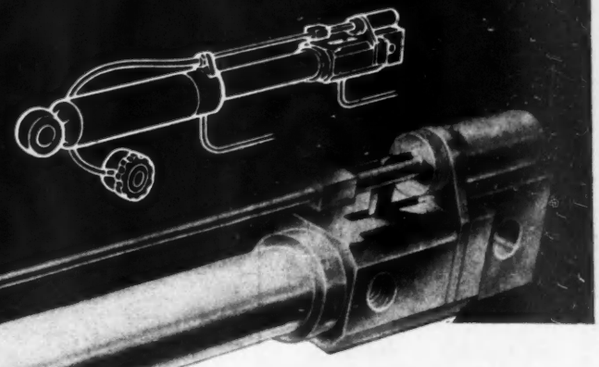

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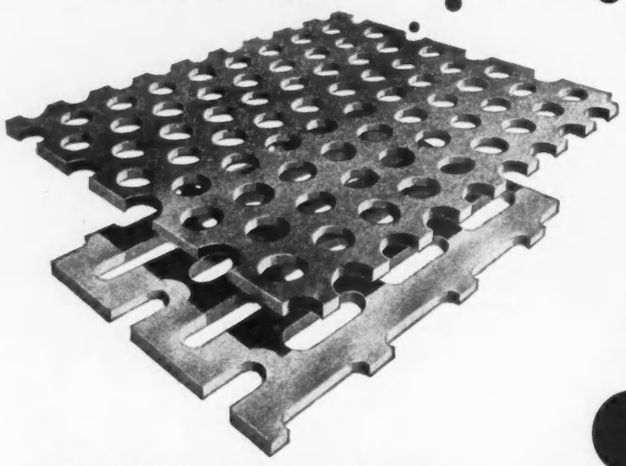

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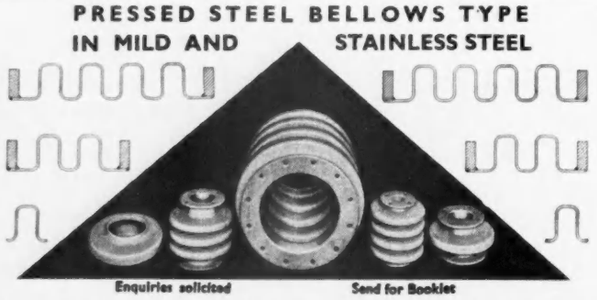

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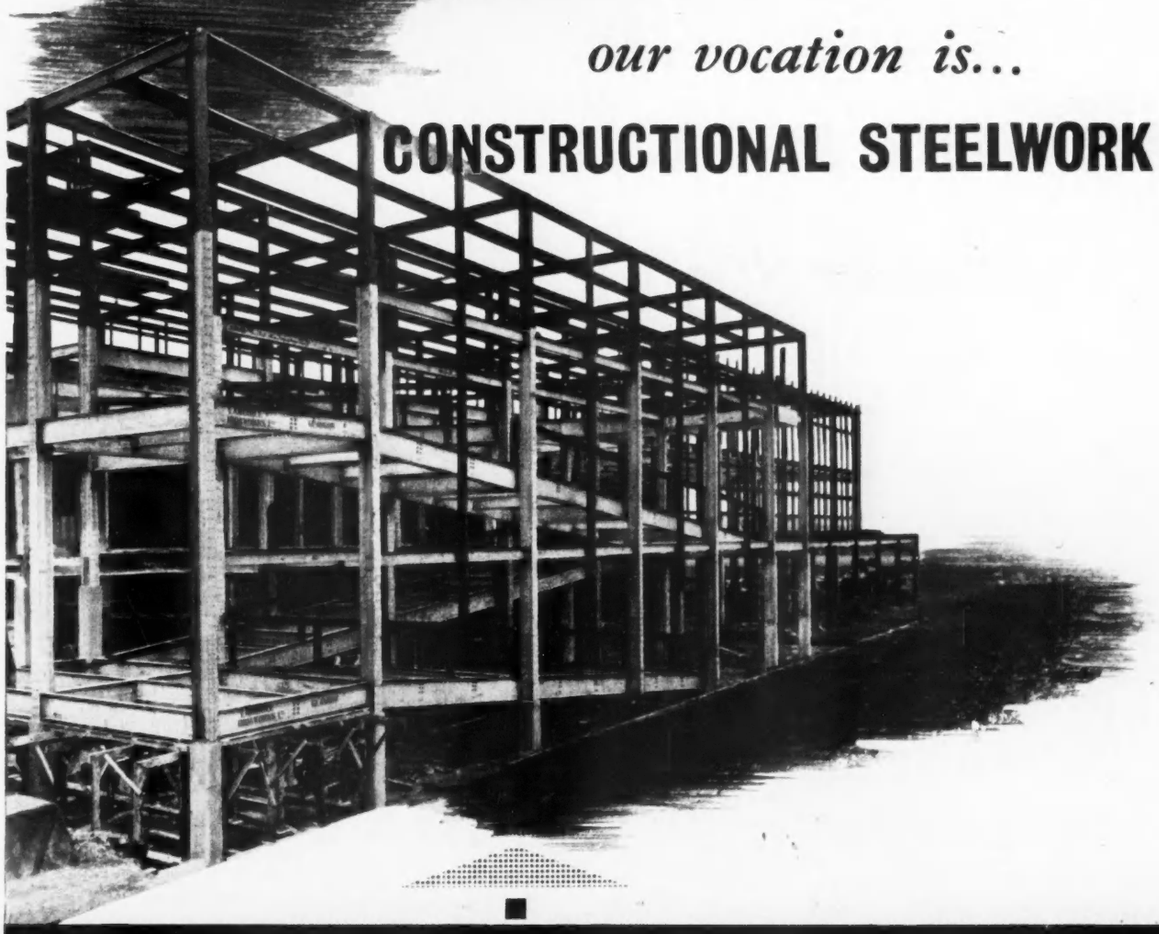

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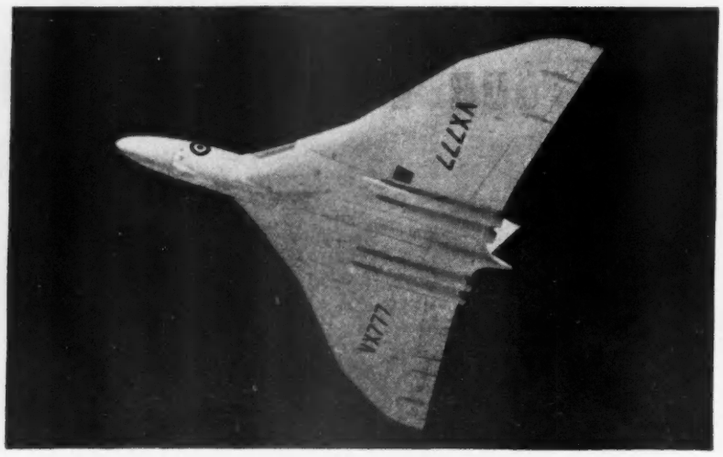
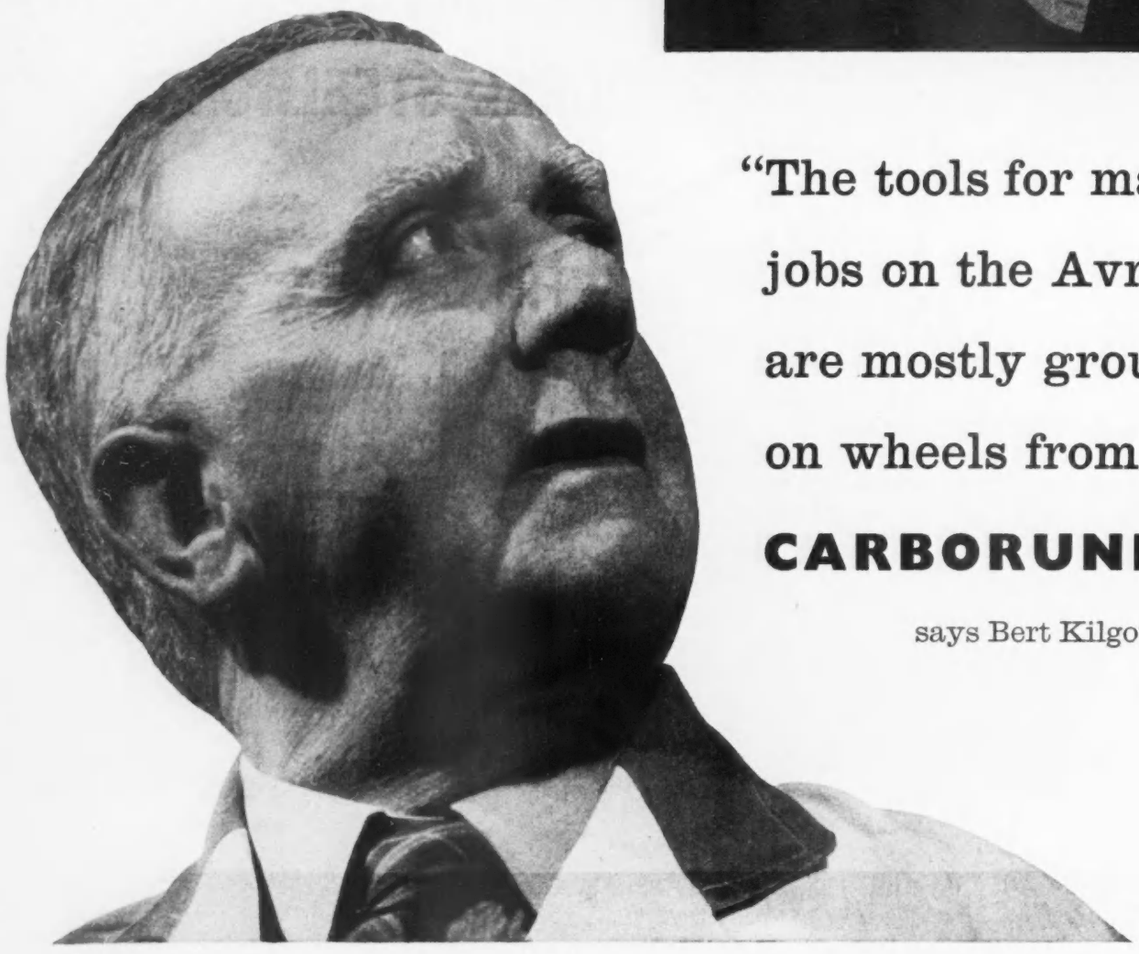
Bert Kilgour has worked at the main factory of A. V. Roe & Co. Ltd, at Chadderton, for 40 years, and is now the senior foreman of the toolroom, in which 300 men are employed: "Must be one of the biggest toolrooms in the country", Bert says. "We started getting grinding wheels from CARBORUNDUM in 1936, and they've supplied most of our wheels ever since then. That's for the whole factory—not just the toolroom. Why? Well, because their wheels do a good job, and give us good service. They've always been ready to help us when we've asked them to."





"The tools for machining jobs on the Avro Vulcan are mostly ground on wheels from CARBORUNDUM"

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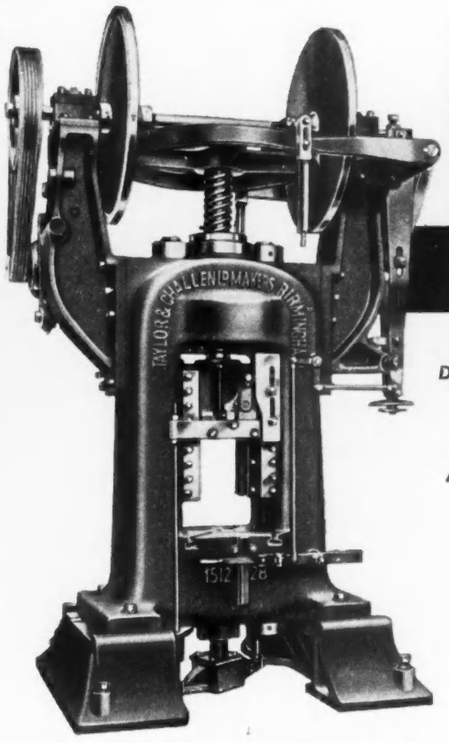

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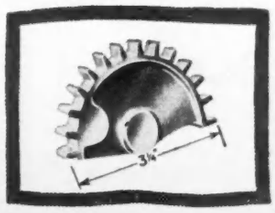

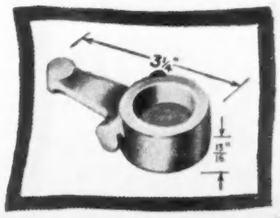

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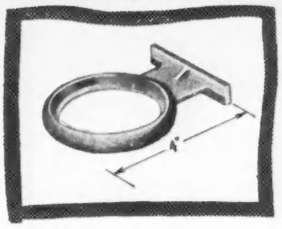

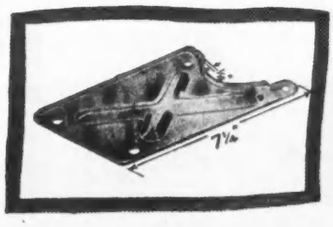

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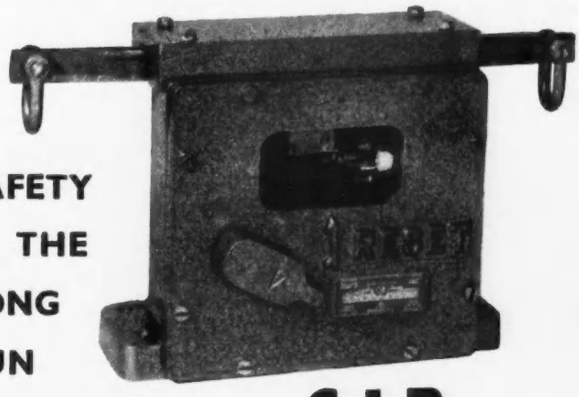

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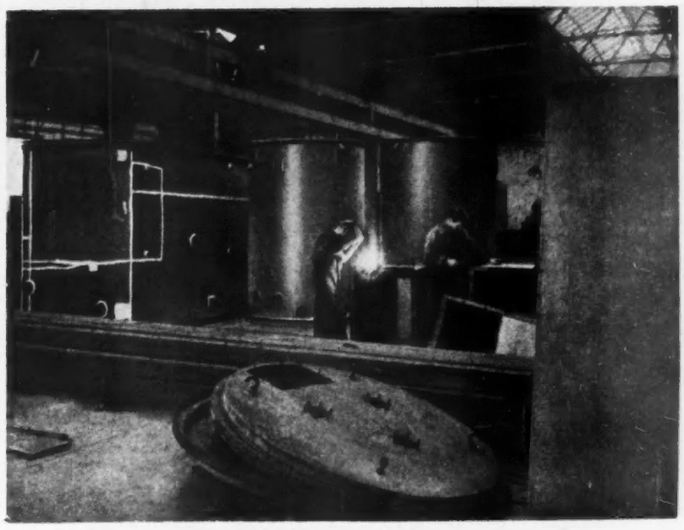

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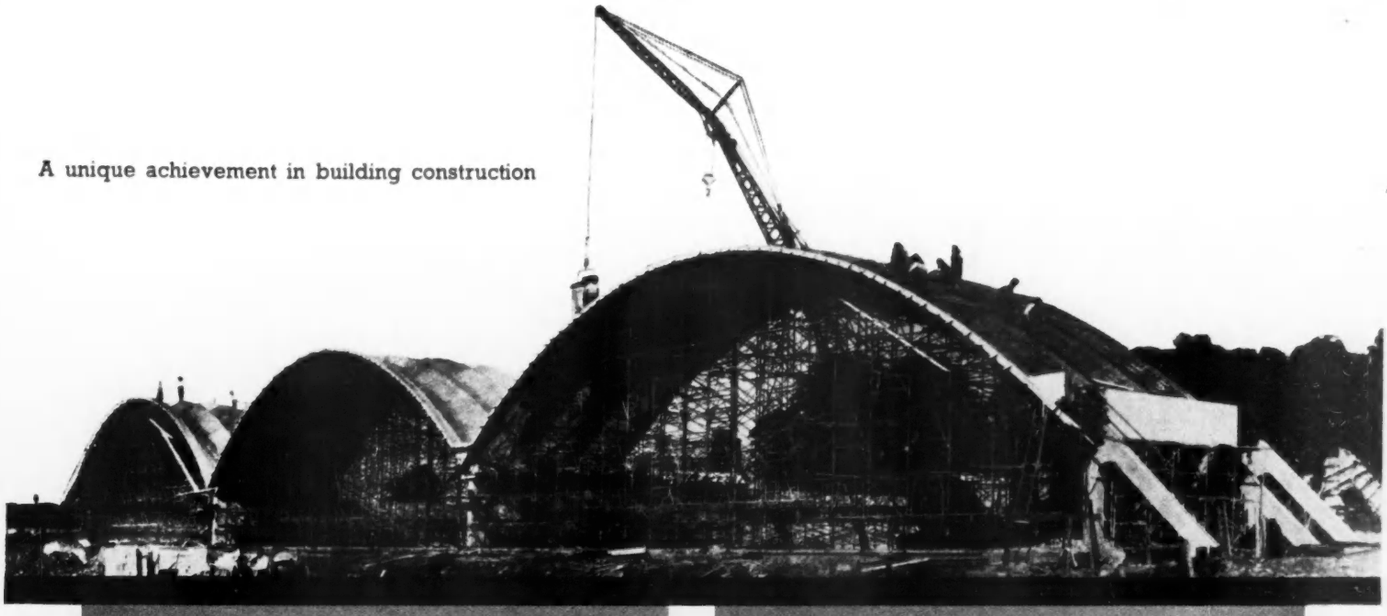

Leggat's achieve a 7 day 'pour and strike' cycle for each 3 span 25 foot section of these Ctesiphon Warehouse roofs at Paisley.

These pictures show the construction of two warehouses each with 3 roof spans of 100ft. for Messrs. Chivas Brothers Ltd., Scotch Whisky Distillers and Exporters, at Paisley by Messrs. Hugh Leggat Ltd., of Glasgow. The roofs are of Ctesiphon Construction and consist of 2½" thick reinforced concrete corrugated arch shells each spanning the full 100ft. Each corrugation has a pitch of 8ft. 4ins. and an overall depth of 2ft. 2½ins. A pre-requisite in designing a scaffolding mobile of this character is the high degree of accuracy required; the whole arrangement working to a tolerance of ⅛".

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CREDITS

ARCHITECT — S. Lothian Barclay, M.A., A.R.I.B.A., A.R.I.A.S., Glasgow.
CONSULTING ENGINEERS — J. H. de W. Waller, D.S.O., O.B.E., M.Sc., M.I.C.E. London, and A. C. Astor, B.Sc., A.C.G.I., B.I.C., London.
CONTRACTOR — Hugh Leggat Limited, Barrhead, Glasgow. Licensees for Ctesiphon Construction.
PATENTEES FOR ROOF — Ctesiphon Construction Limited, 167 Victoria Street, London, S.W.1.

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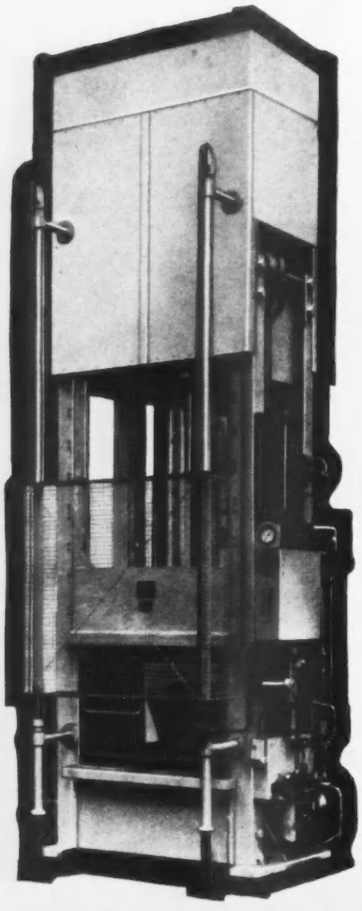

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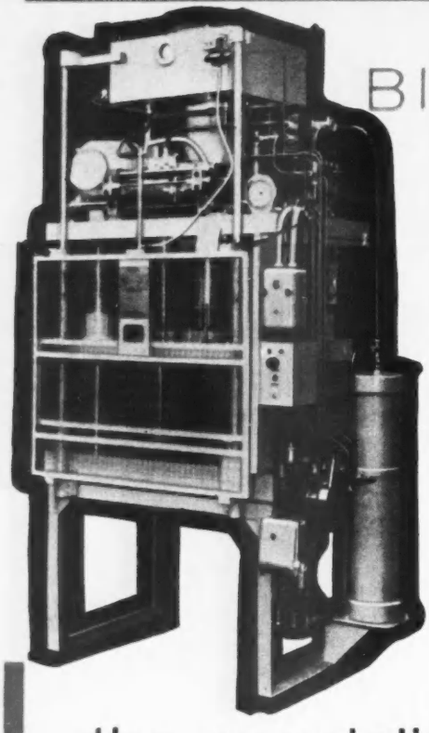

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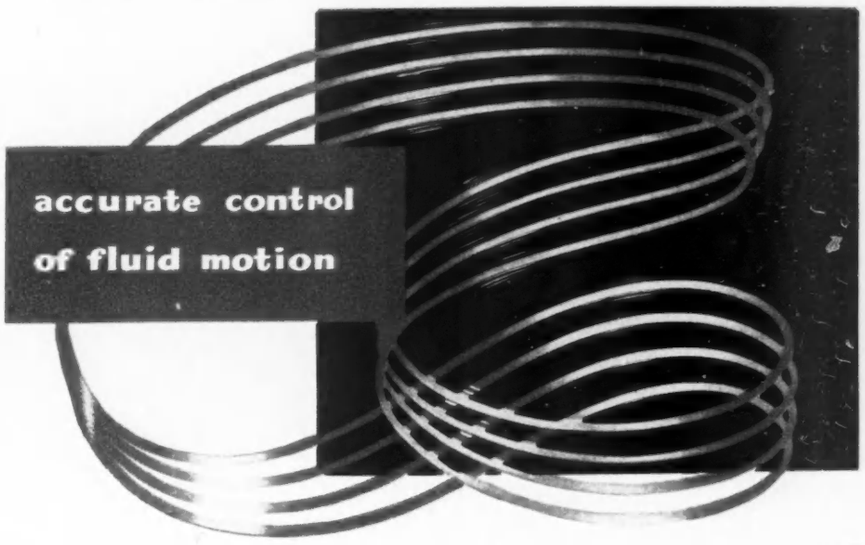

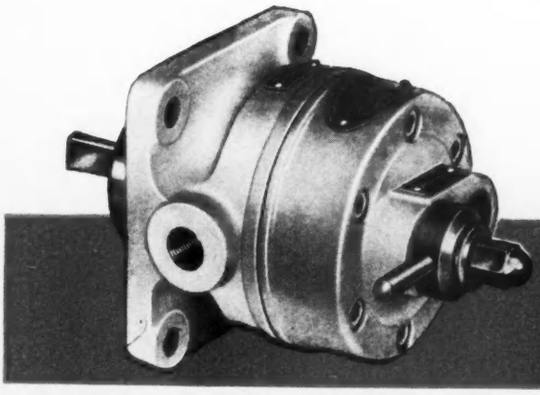

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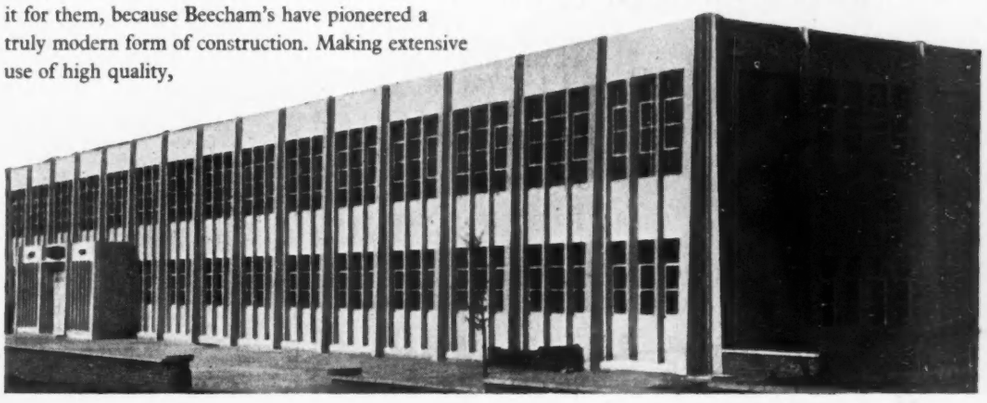

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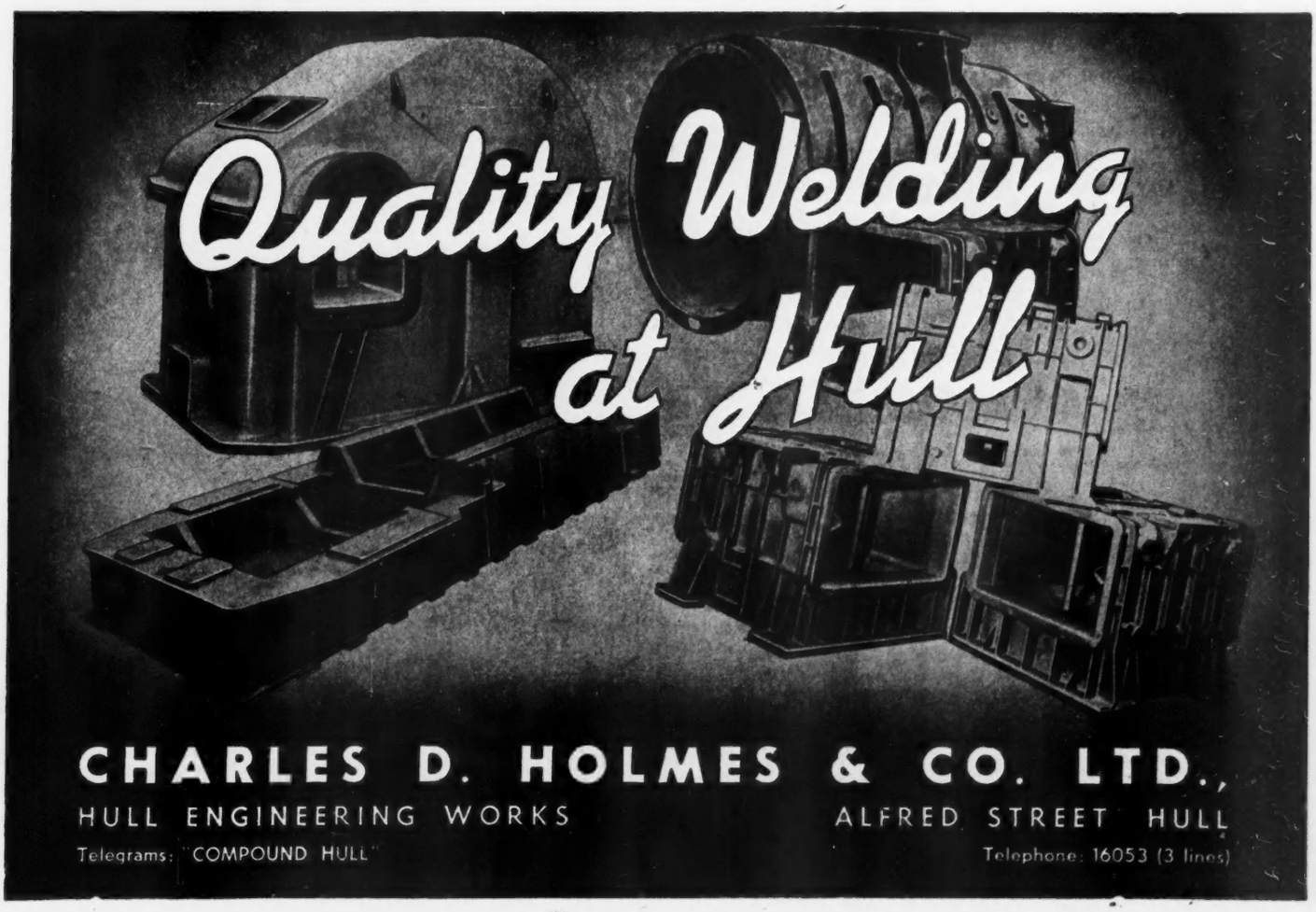

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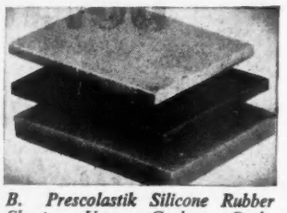

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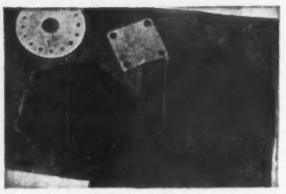

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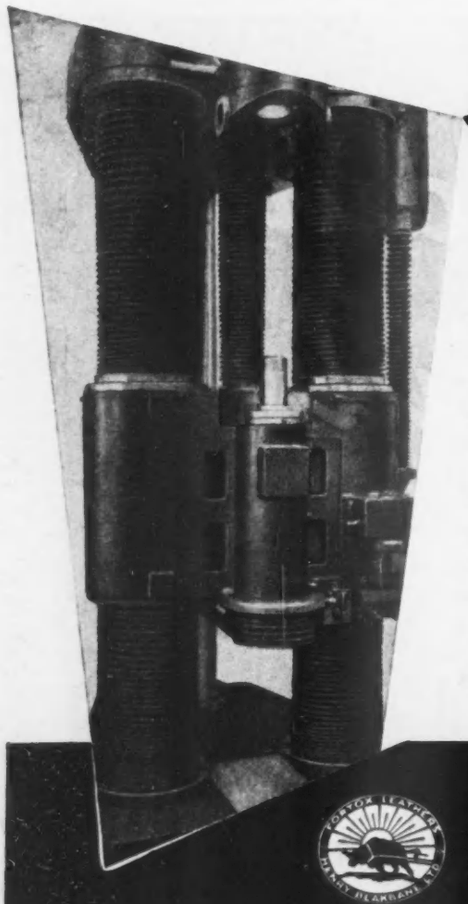

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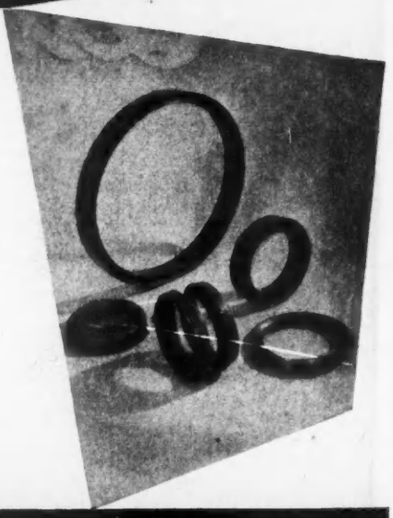

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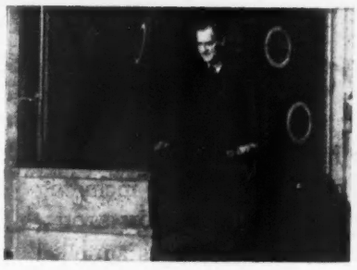

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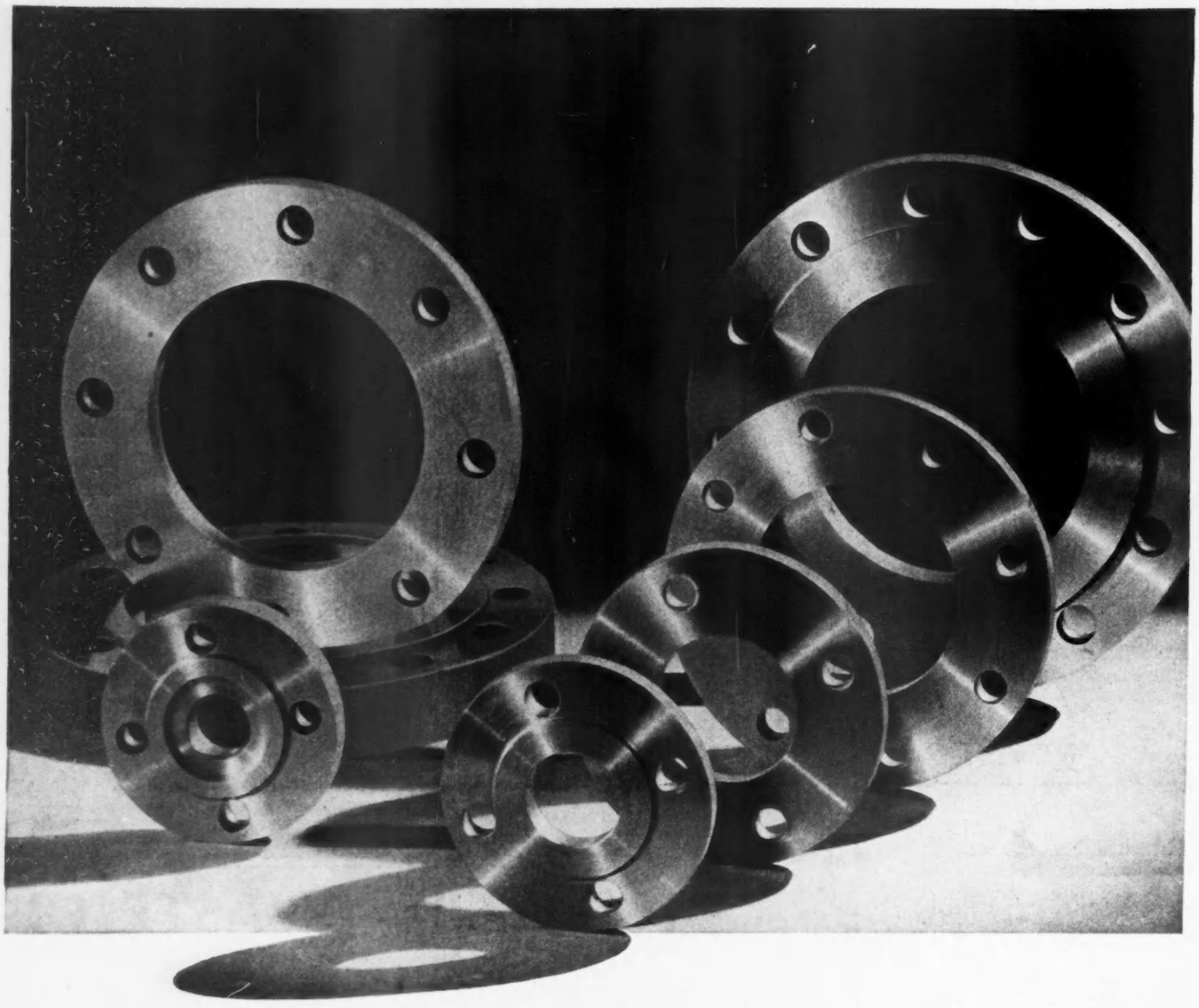

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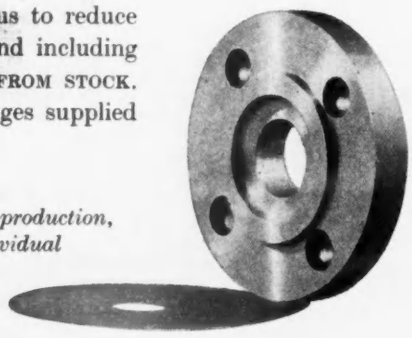

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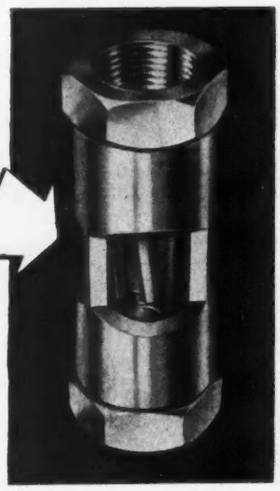

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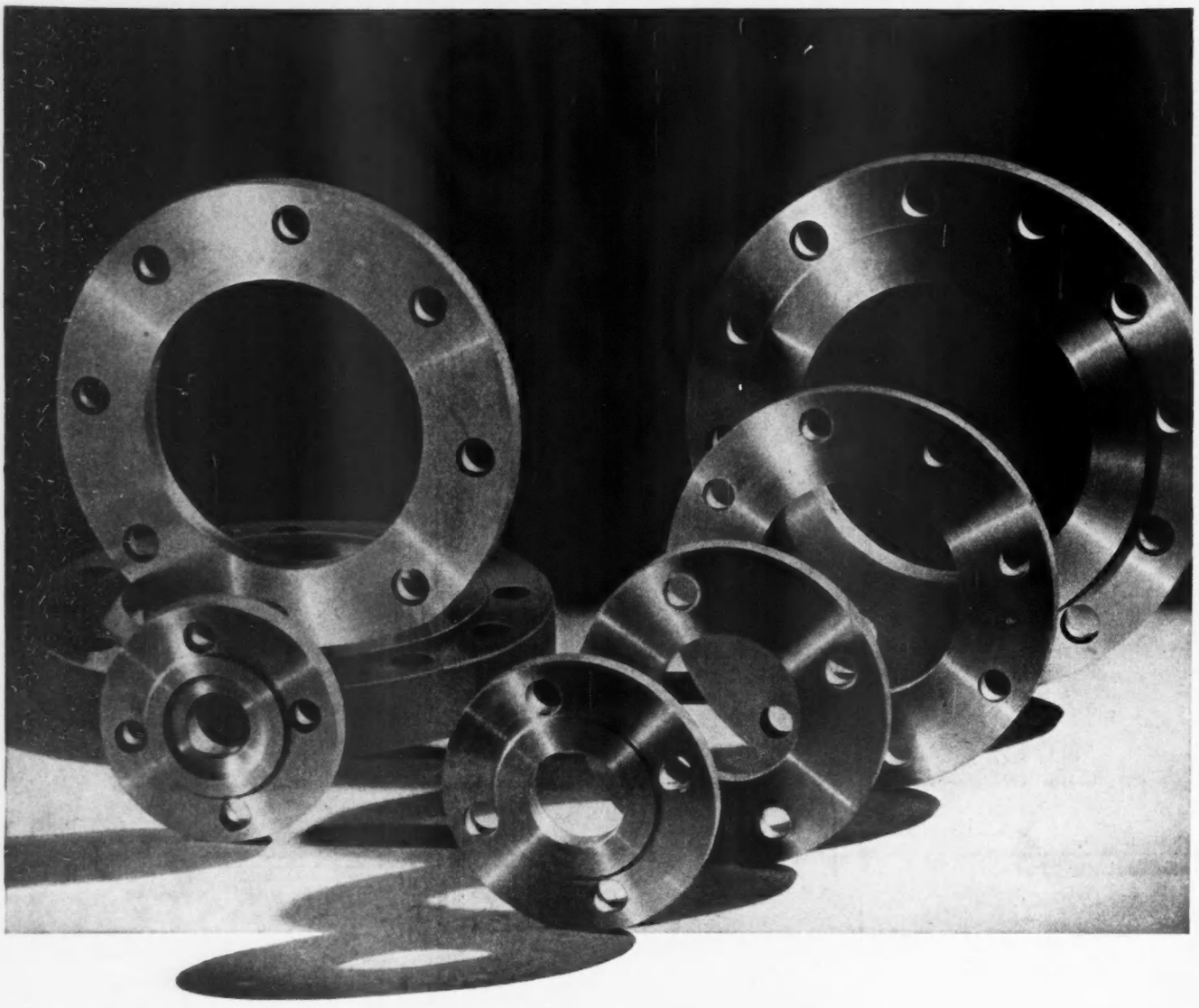

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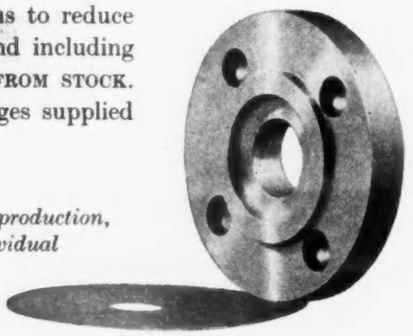

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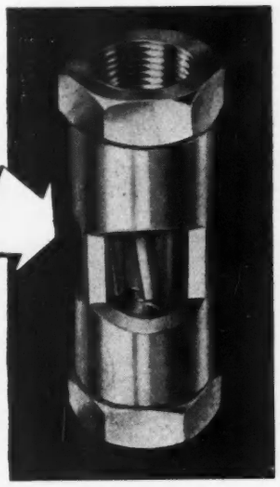

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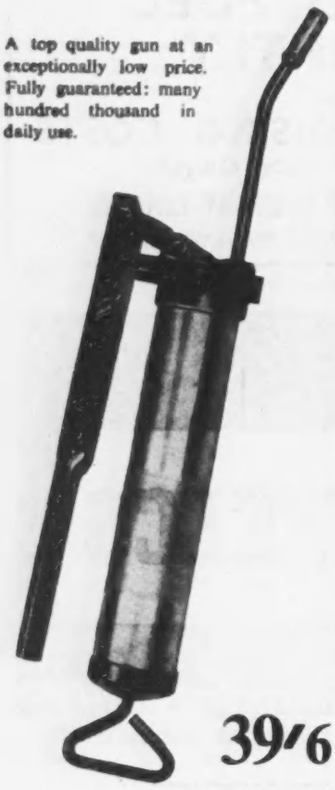

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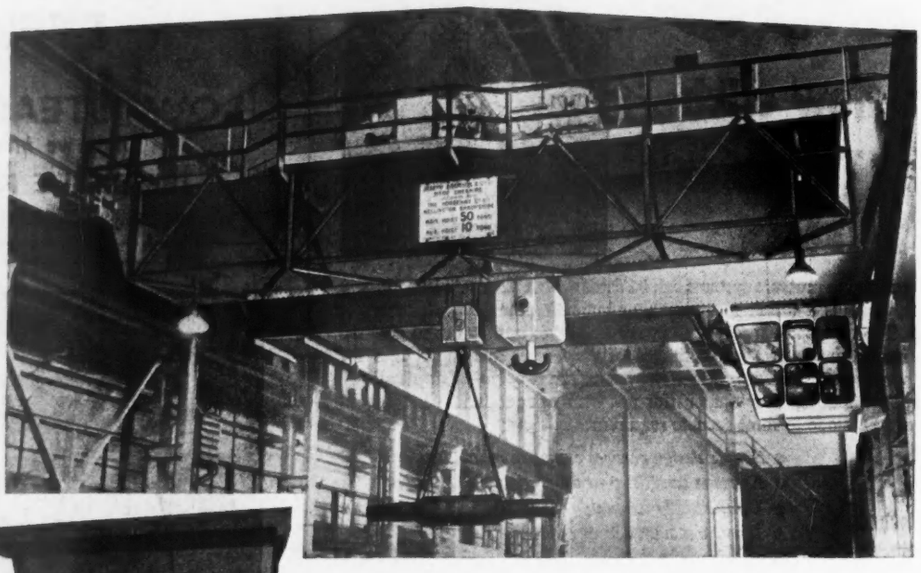

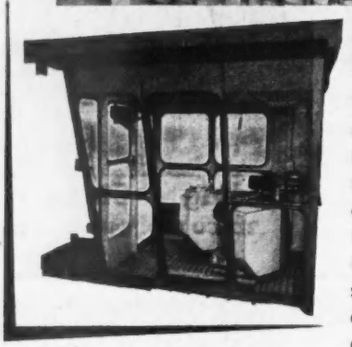

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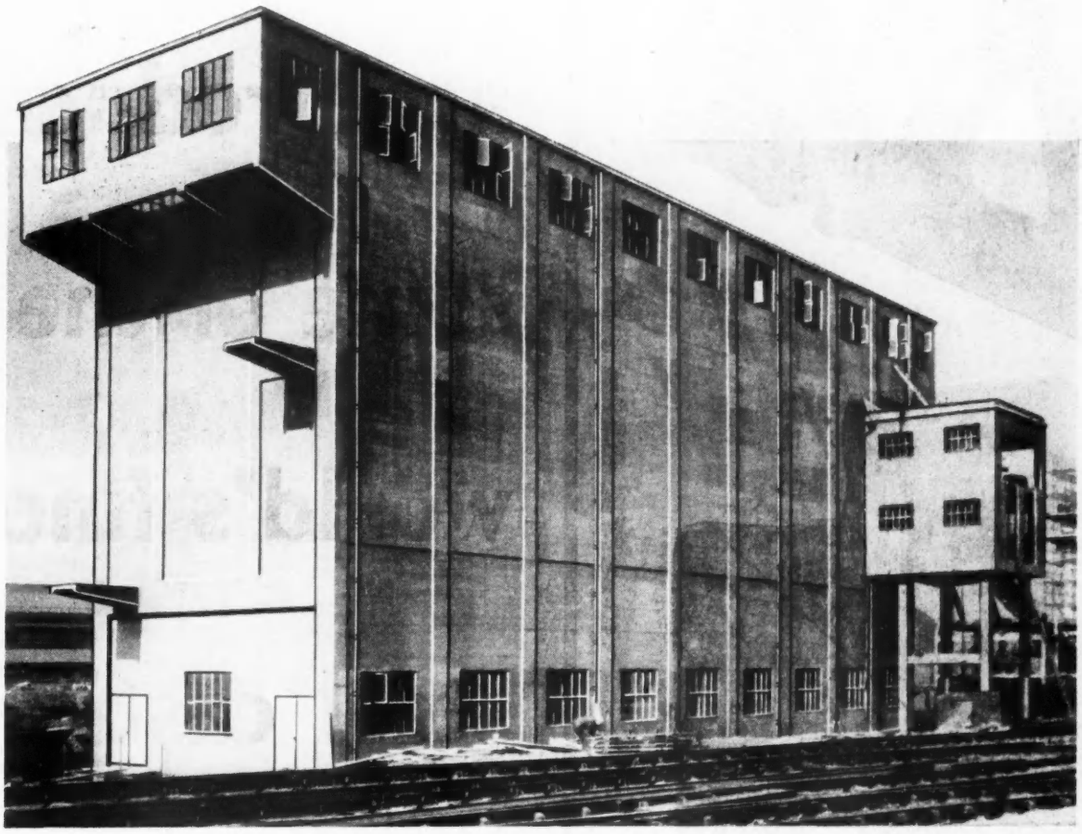

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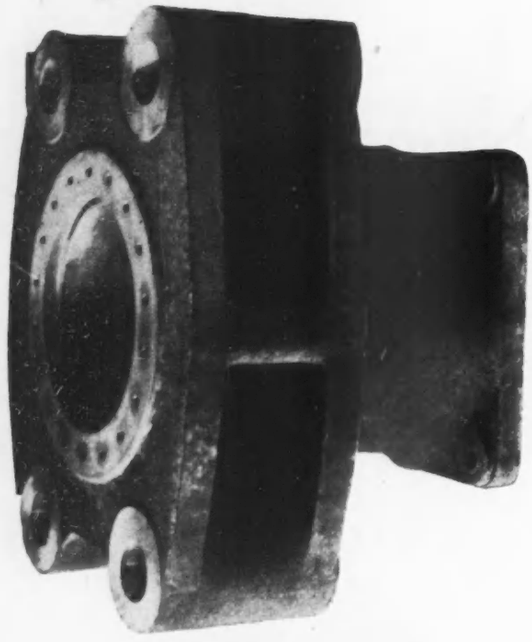

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THE ENGINEER

No. 5403 AUGUST 14, 1959 VOL. 208

PICKING UP THE BITS

In the seven " emergency " issues which have appeared since the dispute in the printing trade began we have tried to discuss though necessarily more briefly than usual many of the matters on which we have thought readers might be interested to read our comments. Necessarily, however, a longer interval than usual elapsed between the event and the appearance in print of our comments upon it. Press day for the last few weeks has been over a week earlier than usual and each issue has tended to be delivered late ! Now, therefore, that we begin in this issue to revert to our normal late hour of going to press (even though we shall not recapture our full size until next week) it becomes desirable to refer shortly to quite a number of recent events. We have, in fact, to " pick up the bits " which might otherwise get lost ; and place them on record.

London–Paris Race

Transport figures in two subjects to which reference should be made. The progress of the recent London–Paris race organised by the *Daily Mail* was so well reported in the daily papers that there is no need for us to record any more than that the R.A.F. represented by Squadron-Leader Charles Maughan won it with a time of 40 min. 44 sec. Perhaps the major feature to be noted in this connection is the important part played by helicopters. Without the help of helicopters operating from the centre of London the use of high-speed aircraft would have proved valueless. In fact it was demonstrated conclusively that the way for any commercial operator to reduce significantly the time required for journeys between London and the nearer European capitals lies not in the use of faster aircraft but in the adoption of a kind of aircraft which can operate directly to and from city centres. The Belgians, of course, have been demonstrating the point for the last two years with helicopter services from Brussels. The race threw the point into sharper relief. It also stressed the need to decide early where a heliport of adequate capacity could be sited close to the centre of London.

Trunk Roads

The other transport subject relates to trunk roads. We find it difficult to understand why the Minister of Transport and Civil Aviation became a little hot under the collar upon reading a recent report of the Select Committee on Estimates on this subject. For it is the duty of Select Committees on that subject to be critical ; the criticisms made seem all to have been raised in the press and elsewhere at various times ; and the tone especially of the " Conclusion " of the Report is one of sympathetic understanding of the troubles which can arise when a programme is so relatively suddenly and so very largely expanded as has been the road construction programme. Such criticisms as that research by the Road Research Laboratory into certain subjects had either not been started at all or had been started too late seems well justified ; and also quite understandable. We should add that the liaison which ought surely to exist between the Ministry and the Laboratory has never seemed to us very satisfactory partly, perhaps, because neither party until quite recently could see much chance of certain research results being at all widely applied ! Again criticism that no adequate scheme of priorities for road works appears to exist, though it is certainly exaggerated, is not wholly unjustified. For when a programme of road works is suddenly expanded the only practicable thing to do is to start work upon those schemes which happen to be ready for work to begin rather than upon others which might have been preferred in other circumstances. The situation should right itself later ; and there is, indeed, evidence that this is what is happening. However, judgment of the whole issue must be reserved until the Ministry has completed its reply to the Committee. In our next issue we expect to comment upon the peculiarly uninspiring Report issued by the Committee on London Roads at the end of July.

Nuclear Matters

There are several nuclear matters deserving of mention or comment. First it falls to be recorded that Lord Plowden, who was designated the first chairman of the Atomic Energy Authority, 1954, is to be succeeded in that post on January 1 next by Sir Roger Makins. Sir Roger will take over an Authority whose responsibilities have become so very much enlarged since Lord Plowden became its first chairman that his task may prove significantly different. If he makes as high a success of it as Lord Plowden has he will do well indeed ! Secondly, we need to note that the Minister of Power has authorised the construction of the proposed nuclear power station at Dungeness. A number of objections were put forward at a recent public inquiry into this proposal partly on the ground of the unspoilt nature of the site, partly on the grounds that the area is of special scientific interest, botanically, entomologically, as a bird sanctuary, and as a region being recovered by natural causes from the sea. It seems to have been felt that objectors exaggerated the harm that would be done by the construction of the station ; and, indeed, we feel that objectors often fail to realise how few people are employed by and what little objection there is to a nuclear power station once built. We do wonder, however, whether it is any longer really necessary to site nuclear power plants so far from human habitations. After all, the Windscale accident, though frightening to a somewhat ill-informed public, was particular to that kind of plant. Is there any kind of incident, really possible in newly designed reactors, that could have comparable efforts in spreading radioactively dangerous material over a wide area ? Lastly, we need to note that according to an announcement in the Commons on July 17, legislation is to be introduced

to bring the discharge of radioactive wastes under Government control. The existing control applied to A.E.A. establishments, and which also applies under a 1959 Act to certain other installations, is of a temporary nature. It is felt, presumably, that so many nuclear installations are built, building or planned, and so much use is being made of radioactive materials that the time has come to bring wastes under permanent control. The proposed legislation—subject, of course, to a possible need for critical amendment when its details become available—is to be applauded. How great a pity it is that in the early days of the Industrial Revolution no one was wise enough to perceive how much damage to health and amenity would follow from pollution of the air over this country and so many of its streams, rivers and estuaries !

A Restrictive Practice Approved

On July 31 the Restrictive Practices Court delivered judgment upon that Trading Agreement of the Water-Tube Boilermakers' Association about which we commented in our issue of July 3. It will give great satisfaction that the Court was able to find that abolition of the scheme, operated in the way that it was in relation to overseas orders, would be likely to cause a substantial reduction in the volume of earnings of the export business compared to the total of the whole business. In the circumstances the Court concluded that detriment to the public did not outweigh the national benefit resulting from the maintenance of exports which was anticipated if the scheme continued. Accordingly the Association was held to have discharged the onus cast upon it under the Act of proving that the restriction was not contrary to the public interest. In short, the Association may continue to work the Agreement. However, other associations having comparable agreements would be well advised to study the case with care. For the Court was unable to accept certain contentions of the Association. It rejected, for example, the contention that the existence of the Agreement tended to preserve capacity by allowing firms to retain key personnel in times of recession ; it also rejected the argument that if there were no agreement the collective research department would close down, on the ground that the research expenditure was so small. Nor would it accept the argument that quality would deteriorate ; and the terms of the Agreement were held to be unnecessarily wide merely to protect the members of the Association when faced by a preponderant buyer in this country, the Central Electricity Generating Board. Any associations hoping to justify any kind of restrictive agreement upon similar grounds would be well advised to study the arguments and the judgment with great care.

PEACE IN INDUSTRY

It is now fifty-six years since Frederick Winslow Taylor read the paper entitled " Shop Management," in which he expounded his views on management and revealed the thinking on which these views were based. In what has been recognised as among the more influential contributions to the literature of factory management, Taylor—who had worked as a labourer in a steel mill—laid down two conditions " without which scientific management cannot be said to exist." First, " that both sides take their eyes off the division of the surplus as the all-important matter and together turn their attention towards increasing the size of the surplus," and secondly, that special attention be given to " the accurate study of the motives which influence men." In these days and for long past we have heard rather too much about " both sides " in industry, as if what should be regarded as a common interest must be treated, from time to time, as matter for industrial slogging-matches. Such a conception has long become obsolete in economic thought and its absurdity must sooner or later become manifest throughout industry. If there must be two sides, each should possess objectives directed to the well-being and growth of all those honestly participating in the industry, whatever form it may take. Each side is alike dependent upon the prosperity of the undertaking, and it ought to be an obligation binding on every individual concerned that they take no action which, calculated to reduce the size of the surplus, must cause injury to all. This obligation involves consideration, by each side, of the problems of the other side and we get a good hint of the required atmosphere in an inscription found over the entrance to the Town Hall of Gouda : *Audi Alteram Partem* (" Hear the other side ").

Courtesy in human affairs, whether they be industrial, political or domestic, has an effect analogous with that of lubrication in machinery : it reduces friction and thus increases efficiency while removing or lessening the risk of breakdown. When, on June 7, 1566, Sir Thomas Gresham laid the foundation stone of the Royal Exchange, London, considerable feeling was expressed as to the employment, on the building, of workmen brought over from Antwerp. At all events, six days later the aldermen resolved to petition Gresham in favour of the English workmen. Whether they were successful in their suit does not appear, " but it probably did not much dispose Gresham in favour of the candidates for the employment, that one, William Crow, apparently a bricklayer, had been guilty of ' very lewde demeanour towards Heinrich, the said Sir Thomas Gresham's chief workman.' " It is tempting to speculate as to the nature of this " very lewde demeanour," but we may be certain that Heinrich would not forget his encounter with Bill Crow, who, in the first instance, had forgotten the principle enshrined in the lines : " Moreover (this is very old !) be courteous, even when you scold." Inflammatory language has been a major promoter of costly stoppages and those of us, whether employers or employed, who may be (as many excellent people are) easily provoked to verbal explosion point, should endeavour to remember and apply the advice of Thomas Jefferson, who urged that when angry, a man should count ten before speaking. When very angry, a hundred! Such a procedure acts, in a human machine, much as does a low-resistance squirrel-cage damper winding in an electrical machine. The damper winding is, moreover, particularly desirable for unbalanced loads, and to give maximum pull-in torque for resynchronising after a disturbance. It also reduces to a minimum the transient over-voltage apt to occur owing to an unbalanced short-circuit which might otherwise attain dangerously high values. The offensive controversialist would do well to remember the remark of the old sergeant to the ensign who was beating him : " I beseech your honour not to hurt *yourself*."

We quoted Frederick Winslow Taylor as remarking that one of the two conditions " without which scientific management cannot be said to exist " is that special attention be given to " the accurate study of the motives which influence men." Some of these motives must be deemed primordial and they influence all of us whether employers or employed. We read how the earliest inscription relating to a trade guild is one emanating from a college of cooks—natives of Falerii, near Rome—domiciled about two centuries B.C. in Sardinia. We need hardly doubt that the motives which influenced these

cooks in the second century B.C. bore a strong resemblance to those influencing their descendants in the mid-twentieth century A.D. Conditions to-day are certainly rendered more arduous for a variety of reasons, one of them being the greater difficulty in guiding men into the types of employment for which they are best fitted. We cannot all be so fortunate as was that engine-driver on the Great Western Railway who, retiring after forty years' service, remarked that "If I had my time over again, I should like the same job. I have enjoyed it." Propertius, writing in the first century B.C., urged that "each man pass his days in that wherein his skill is greatest." Whatever may have been the problems in arriving at such occupational felicity during the time of Propertius, they have become more acute in our modern social and industrial organisation. It is here that we look to the leadership on both sides (if we must still speak of "sides") in arriving at means whereby such mutually impoverishing methods of negotiation as strikes or lock-outs can become recognised as painful absurdities no longer to be tolerated. The thinking on these lines will surely be stimulated by the recent settlement of the printing dispute, in which settlement emphasis was placed on the importance of measures for improving efficiency and for abandoning practices which impair economical working. Contemplating the terms of that settlement, we find it very difficult to believe it could not have been reached without a seven-week stoppage of work.

BEATING INFLATION BY LOWERING PRICES?

The more we see of the reports of the Council on Prices, Productivity and Incomes, the more uncertain we become about their usefulness. The third report has now been published and once again it proves to be a document supporting the Government's view of the nation's economy. In some respects these reports merely duplicate what Economic Surveys have to say. It is, of course, true, as the council stresses in the present report, that it has always regarded it as its first duty "to present the facts and figures about the movements of prices, productivity and incomes in language intelligible not only to economists, but to all who may have an interest in these questions." But this third report can hardly be regarded as a "popular" presentation of the facts. It is less popular, for example, than the popular version issued with each Economic Survey. To whom then is the council really supposed to appeal? Was it not the original intention that it should keep everyone, more especially perhaps wage earners, informed about the intimate connection between increases of wages and salaries and inflationary increases of prices? Yet we do not think many wage earners, nor, indeed, many salaried people, other than economists (and, of course, editors !), will bother to read this third report.

Much that is printed in the report is platitudinous. For example the Council thinks "it is a particularly unfortunate feature of the restraints necessarily applied to check inflation in the past that in practice they have slowed investment down more than consumption." Every commentator upon economic matters has been saying that same thing ever since the credit squeeze began. Again, "the guiding principle that we would emphasise . . . is that the country should seize the opportunity of advancing to higher output and higher real incomes without involving itself once again in the spiral of rising pay, profits, and prices, which can only bring another setback." Shades of Sir Stafford Cripps ! Did he not say something very like that about ten years ago? How many others have since said the same thing? The real trouble is that economists seem unable to give satisfactory guidance as to how to achieve so desirable a state. As the council remarks in this report, "experience so far has seemed to confront us only with a harsh choice between steadier prices with slower growth and less employment, on the one hand, and expansion with full employment accompanied by inflation, toppling periodically into crisis, on the other." The council's present nostrum appears to be that manufacturers should now reduce prices, because a rise in output per head is likely to occur as total output expands so that if money rates of pay and prices of imported materials do not go up unit costs should fall. The council goes on to show how very much better it is to improve living standards by reducing prices than by raising incomes. Most commentators, even possibly trade union commentators, would agree. But what are the factors that really settle what prices shall be? Not so very long ago economists would have said prices are settled by the "laws" of supply and demand—that is, that if demand picks up, as it should if output is to expand, prices are likely to rise, not fall. It is, in fact, obvious that economists do not yet know how to control an economy. In a final chapter the council reviews a number of proposals, some of which have been tried abroad, for the regulation of a nation's economy. None seems to have been particularly successful in preventing inflation.

The Engineer—100 Years Ago (AUGUST 12, 1859)

"RAILWAYS IN LONDON"

"The London traffic becomes yearly more unmanageable. In proportion to its rapid aggregate growth does it concentrate also in the principal thoroughfares, already overcrowded. In Cheapside, for instance, the traffic is steadily increasing, and yet Cheapside, hardly passable now, is growing no wider. Twenty, ten, or perhaps even five years' increase of this traffic, at its present rate of growth, will effectually dead-lock all communication between Tower-hill and Temple-bar. Something must be done; what must it be? Whatever plan is proposed is likely to be costly; yet the cost at which inevitable improvements must be made, will increase with every year of neglect. Never before did we so much need that London should have been rebuilt by Sir Christopher Wren upon the admirable plan which he prepared after the great fire . . . . .

"However the question of London traffic may be disposed of, street tramways or horse-worked railways will render great assistance in its management. Anything that will condense our carriage travel and increase its rate of motion, will greatly aid in keeping the streets clear. In proportion to the number of passengers carried, the cabs cause by far the greatest obstruction of the traffic. A file of cabs a mile long may contain no more than 300 or 400 passengers, and the procession may exceed a quarter of an hour—more likely half an hour—in passing the Poultry . . . . If the 300 or 400 cab-passengers under notice could be induced to go by the carriages of a city tramway company, fifty or sixty together, the whole number could be accommodated in a distance of 20 rods along the street, and they could all be carried past a given point in less than one minute. In tramway carriages, of suitable construction, unexceptionable accommodations might be provided, and such a mode of conveyance rendered attractive and really popular."

Power for the Long-Range Supersonic Airliner

No. I

At the Summer Meeting of the Institute of the Aeronautical Sciences in Los Angeles last June, Dr. R. R. Jamison, head of the ramjet department of Bristol Siddeley Engines, Ltd., presented a lecture expounding the applicability of integrated turbo-jet/ramjet power plant. We reproduce the greater part of this lecture.

IN investigating what power plants will best meet the needs of the long-range supersonic airliner we have to postulate that there will be such an aircraft and we need further to have some idea of its nature to match the engines to it, while equally the kind of engines which could be available will react on the design of the airframe. So it appears that we must look at these two fields at first separately and then jointly in order to evolve a design specification for the complete aircraft. Moreover, the whole conception of a modern commercial aircraft has become so complex, in meeting a great diversity of operational requirements, that even in the fairly narrow process of matching the airframe and its engines a wide range of factors must be taken into consideration.

Our investigation into a new commercial aircraft must, therefore, start by looking at what we have and considering what is needed to improve it. It is clear that what the airline operator sells against rival forms of transport is speed in travelling from point to point on the earth's surface and that increased speed will continue to sell as long as it can be offered at a price the customers will pay. Experience has taught us that the price of speed may be paid in discomfort and inconvenience as well as in money so these, as well as safety, must be taken into our thinking. Adequate range in our aircraft has also come to be recognised as important either because long ocean crossings may be necessary or because a series of intermediate stops cost too much in inconvenience and lost time. Thus we see that for the "mainliner" there is a recognised association between speed and adequate range: both are in demand and the first is hard to exploit without the second. The jet airliners of the current generation are operating as fast as they can fly without incurring the severe drag penalties associated with transonic flight with the present airframe designs. In fact we are up against what is virtually a discontinuity in the aerodynamics so that the smooth gradation of flight speed as a function of development time is interrupted. This means that extrapolation of previous behaviour is a risky way of choosing a new aircraft specification for assessment and a critical examination of the fundamental evidence is needed.

Airframe and Engine Characteristics

Our general field of study will be in the speed range from Mach 0·8 upwards to as far as it seems reasonable to go; it appears that the kinetic heating of the structure places a limit on the upper speed to be considered. The air stagnation temperature at $M=3$ in the stratosphere is about 600 deg. K. (1080 deg. R.) and at $M=4{\cdot}5$ about 1050 deg. K. (1890 deg. R.) so it looks as if $M=4{\cdot}5$ is a reasonable upper limit for the present study. Now the properties of an aircraft in which we are mainly interested are the payload, range and speed and these are brought together in the Breguet formula for range:

$$R = C\,\frac{V}{SFC}\,\frac{L}{D}\log_e\frac{W_1}{W_2}$$

where

R = Range
C = A constant to reconcile the units
V = Flight velocity
SFC = Specific fuel consumption
$\frac{L}{D}$ = Aircraft lift-drag ratio
W_1 = Aircraft weight at start of cruise
W_2 = Aircraft weight at end of cruise to range R

This equation can be re-written:

$$R = C' H_c \eta_0 \frac{L}{D}\log_e\frac{W_1}{W_2}$$

where

C' = Another constant to reconcile units
H_c = Calorific value of the fuel
η_0 = Overall propulsive efficiency $= \dfrac{\text{Work done against Drag}}{\text{Fuel heat input}}$.

In this form L/D is a principal characteristic of the aircraft aerodynamics and η_0 epitomises the power plant propulsion characteristics. The term $\log_e W_1/W_2$ is responsive principally to the airframe structure and engine weight. However, the terms η_0 and L/D are dominant in determining the range potential of an aircraft (assuming a specified fuel, for H_c is obviously also a first order variable). In this analysis a practical outlook dictates the use of a hydrocarbon fuel such as aviation kerosene.

In Fig. 1 a representative plot of $L/D_{(max)}$

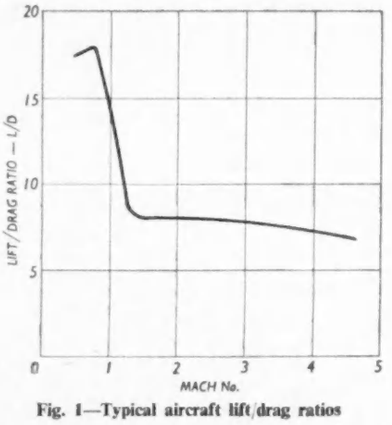
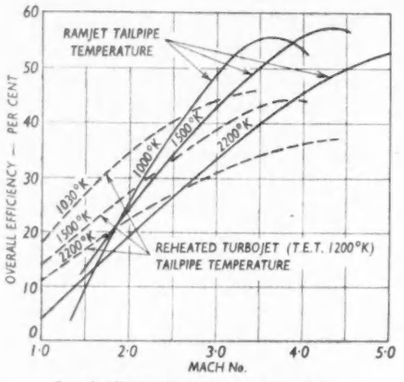


Fig. 1—Typical aircraft lift/drag ratios

as a function of flight Mach number is given which shows a striking fall from a value of about 18 at $M=0{\cdot}8$ to about 8 at supersonic speeds of $M=1{\cdot}2$ upwards. This curve of course reflects a trend, but nonetheless typifies the general aerodynamic situation with present techniques. The absolute values are arguable, but the significant point is the dive of L/D in the supersonic regime to less than half of its subsonic value. At first sight this is most depressing for the hopes for a supersonic transport. Now consider the propulsion side. It is assumed in this paper that continuous flight through the atmosphere will be used and that ballistic, boost-glide or ballistic-glide flight paths represent a new order of difficulty which may, in fact, preclude these techniques from ever being employed for passenger transport around the earth. On this assumption attention has been confined to air-breathing units. The turbo-jet, now proven in long-range transport operation, comes in first for consideration but as the speed rises the ramjet establishes a firm claim as a propulsion unit for the cruise phase on account of its light weight, high efficiency, simplicity and cheapness.



Overall efficiency based on net gauge thrust

Fig. 2—Reheated turbo-jet and ramjet comparison

The true variation of the engine performance with Mach number is presented in Fig. 2, which is a plot of overall propulsion efficiency η_0, as used in the Breguet equation, against flight Mach number in the stratosphere. The relative performance of turbo-jets and ramjets is displayed but a most striking and significant factor is the way in which the overall efficiency increases with increase in speed, from a best value of 18 per cent for a turbo-jet at $M=1{\cdot}0$ to 55 per cent for a ramjet at $M=3{\cdot}5$.

Now as the range factor is proportional to the product $\eta_0 L/D$ this suggests that by flying fast enough the heavy fall in the supersonic values of L/D can be repaid by the rise in the propulsion efficiency. This is demonstrated in Fig. 3, which shows a plot of the range factor against Mach number for the optimum power plant from Fig. 2. Fig. 3 shows that we might expect the range performance of the high-subsonic aircraft to be restored between $M=3$ and $3{\cdot}5$ provided that no serious deterioration in the structure weight occurs. This, then, gives a clear pointer to the picture which is likely to

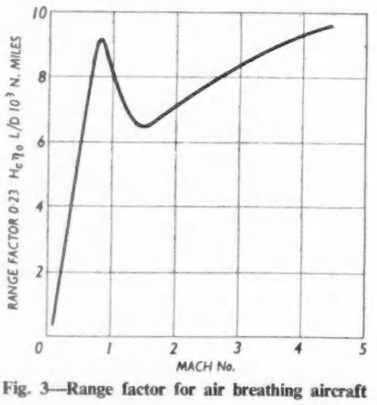


Fig. 3—Range factor for air breathing aircraft

emerge from a detailed study of the performance specification for a long-range supersonic transport and, in particular, it shows that the ramjet, which has a superior performance to the turbo-jet above $M=3$, deserves serious consideration as a component of the power plant, especially in view of its low weight and cost.

The Combination Engine

The ramjet engine would clearly meet all requirements during cruise at $M=2{\cdot}5$ and upwards with an important gain in payload resulting from the low engine weight (about 30 per cent of the equivalent turbo-jet, both engines fully installed with variable nozzles). This could be fully exploited in a composite aircraft, with a launcher component carrying a purely ramjet powered cruise component up to operational altitude, and this technique might indeed have important military applications. However, in the present studies, it has been assumed that we require an aircraft capable of operating in a normal manner, with full civil safety standards, from normal airfields. This means that if ramjets are used they must be applied in combination with enough turbo-jets to satisfy these standards. Such an arrangement is called a " turbo-jet-ramjet combination engine," or, briefly, a " combination engine." This can be made up in various proportions of the two components ; these are designated by the areas of intake duct feeding them with air. It might be suggested that 1200 deg. K. (2160 deg. R.) for cruise and 1250 deg. K. (2250 deg. R.) for take-off are rather modest values to take for the turbine entry temperatures of turbo-jet engines to be developed during the likely time scale of this kind of project. However, this has been done advisedly on the grounds that :

(*a*) Noise at take-off would be excessive with hotter engines.

(*b*) Blade, disc and bearing cooling will be more difficult when the ram temperatures are in the region of 300 deg. to 400 deg. Cent. (550 deg. to 750 deg. Fah.).

(*c*) Extensive operational experience under supersonic flight conditions will be difficult to acquire, so it seems prudent to limit the technical problems in engine development.

(*d*) As the later development of this analysis will reveal, the need for sophisticated and highly developed turbo-jets may be avoided by introducing ramjets in the combination engine.

Power Plant Installation

At this point it is important to consider the installation of the engines in their power plants. A notable characteristic of the supersonic long-range aircraft compared with the subsonic one is the relatively large airflow through the power plant. This derives from two effects :

(i) Owing to the fall in lift-drag ratio from around 18 to values of 7 or 8, the cruise thrust required per pound of aircraft weight is increased by a factor of 2 to $2\frac{1}{2}$.

(ii) Additionally, as can be seen from the curves of Fig. 2, the best values of η_0, the overall propulsion efficiency, are realised at low jet temperatures and, therefore, at low figures for specific thrust.

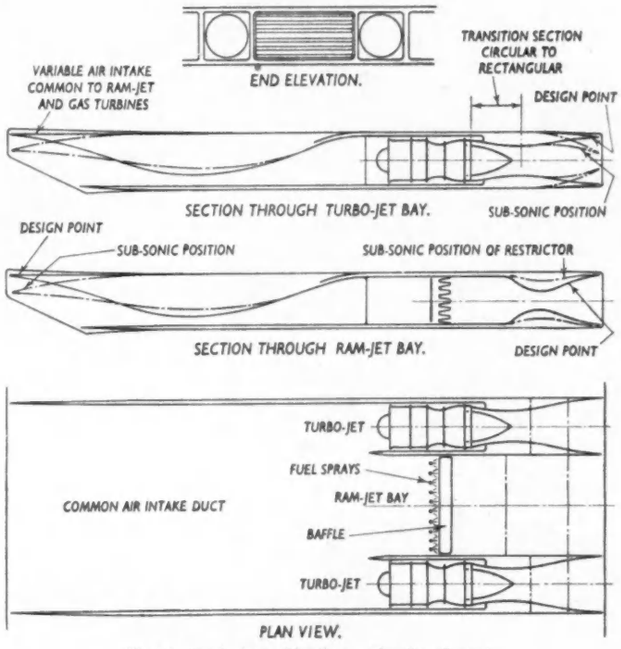


Fig. 4—Typical combination engine bay layout

These factors combine to produce a need for large engines, with equivalent intake and exhaust ducts, which are three or four times as great in area as those in subsonic jet aircraft. This would mean, if the engines were installed as pods, that large penalties in wave drag and skin friction drag would be incurred, so if the severe fall in lift-drag ratio is not to be further aggravated it is most important to integrate the power plants and their air ducting into the airframe design. If this is correctly done an installation can be realised which incurs virtually no power plant drag at all under cruise conditions. Some intake cowl and pre-entry drags might be encountered in the climb and acceleration phases.

A diagrammatic representation of a suitable duct layout is given in Fig. 4. The duct is rectangular and the top and bottom surfaces may be taken as parts of the main wing surface. Under design conditions the shock system from the intake wedge would be entirely confined within the duct so that there would be no external wave drag due to the intake duct as such. This arrangement, in fact, would have the aerodynamic characteristics of a flat plate of zero thickness contributing to the main lifting surface of the aircraft. The internal duct losses would be debited in the normal way to the engine performance. A possible layout of a " combination engine " power plant is shown in Fig. 5. This type of integrated engine-duct installation has been assumed in the subsequent analysis of the optimisation of the air-frame power plant combination.

Typical Engine Performance Figures

To give a general idea of the relationship of the three forms of power plant specified, Fig. 6 has been plotted. This shows how the total weight of engine plus fuel consumed varies with cruise Mach number. The " fuel consumed " contains an allowance for the consumption during take-off and climb to cruise altitude and in all cases a total range of 4000 nautical miles has been taken. The aircraft cruise lift-drag ratio has been taken constant at a typical figure of 7·5.

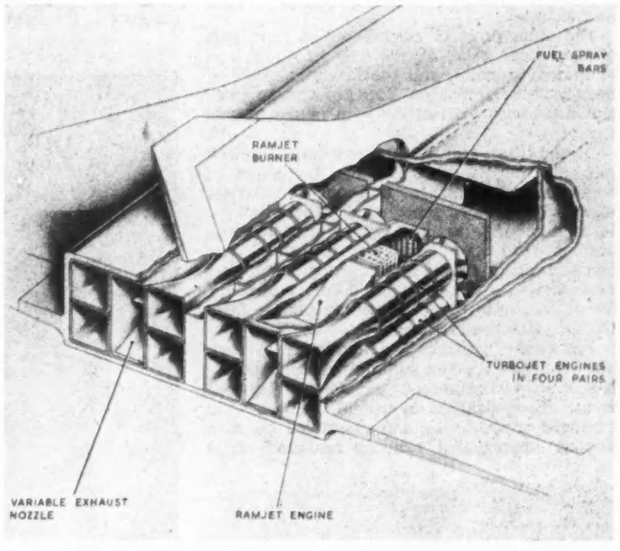


Fig. 5—Cutaway view of engine bay

In the case of the combination engines a proportion of turbo-jets sufficient to give a take-off thrust-weight ratio of 0·4 was assumed. This plot brings in the effect of engine weight in addition to thrust and specific consumption. It can be seen from this diagram that at $M=2$ there is little to choose between the pure turbo-jet and the

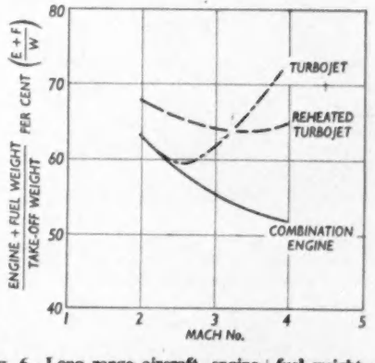


Fig. 6—Long range aircraft, engine + fuel weight *v.* Mach number

combination engine but that the curves diverge significantly at $M=3$ and above and, while the turbo-jet with afterburner overtakes the plain turbo-jet just above $M=3$, the combination engine is still very much

superior. An arbitrary fixed airframe performance has been taken in this case but a good picture is obtained of the influence of the power plant type and the cruise speed on the payload capacity to be expected. It is apparent again that a Mach number of three is a good value to take for detailed study, as reasonable payloads may be expected without encountering the more intense engineering problems arising from kinetic heating at higher speeds.

(To be continued)

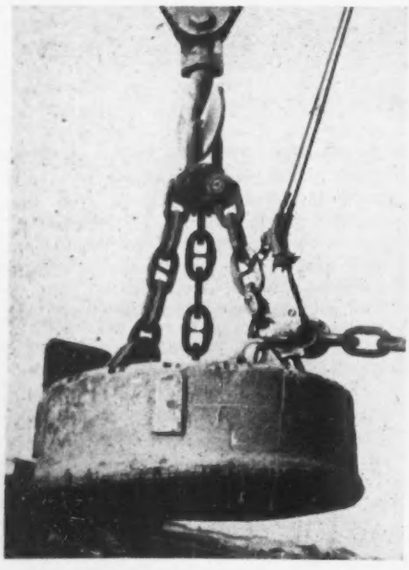
Heavy Duty Lifting Magnets

A SERIES of lifting magnets with diameters of 57in, 62in and 67in has been introduced by Electromagnets, Ltd., Bond Street, Birmingham, 16, for applications where usage is particularly rough and beyond the capabilities of the firm's normal design of lifting magnet. These magnets, one of which we illustrate, are of super intensity design with a shell and poles of high permeability magnet steel.

The outer poles of skirted design form part of the outer shell of the magnet to impart additional strength, and the inner poles are of deep heavy construction. Both poles are spigoted and fitted with seals at the joint of the magnet shell.

Lifting lugs and a terminal box are cast integrally on the magnet shell, the design of which provides sufficient radiating surfaces for dissipation of heat generated by the windings. A double entry terminal box is fitted with an armour plate cover, and entry is through two compression glands providing for single-core cable leads. A hinged steel cover is provided for protection of the leads against damage from the sling chains and crane hook.

The four "pancake" design coils in each magnet are of chevron section high conductivity copper strip with fireproof asbestos tape between turns. Each pancake is wound on to a solid gunmetal support ring and assembled on to a silicone impregnated resilient insulated metal former with silicone impregnated resilient insulation between pancakes. Each coil is impregnated with silicone insulation varnish and enclosed in a robust bobbin, the whole assembly being designed to withstand severe shock treatment.



Lifting magnet designed and built for rough usage. This magnet is being used for lifting a 20-ton skull cracker ball, and it has lifted some 40 tons of scrap

The 57in magnet weighs 9000 lb and has a consumption of 60A; the 62in magnet weighs 11,500 lb and has a consumption of 83A; and the 67in magnet weighs 15,600 lb and has a consumption of 95A.

"Merlin" Research Reactor

"Merlin," which is Great Britain's first privately-owned nuclear research reactor, was made critical on July 16. It is a pool reactor (maximum fast flux 6×10^{13} neutrons per square centimetre), built by the A.E.I. John Thompson Nuclear Energy Company, Ltd., at the fundamental research laboratory of Associated Electrical Industries, Ltd., Aldermaston, Berks.

"MERLIN," the A.E.I. research reactor, was originally designed for a thermal power of 1MW but was redesigned for 5MW. It is a "pool" reactor, cooled and moderated with water, and it uses enriched fuel (more than 90 per cent ^{235}U). It will be used for pure and applied research as well as for the training of physicists and engineers. The general programme of work includes studies of irradiation effects on materials and of Cerenkov radiation in reactors; the compilation of nuclear data; neutron diffraction and neutron cross-section measurements; activation analysis; reactor control and safety studies; and the production of short-lived radioisotopes.

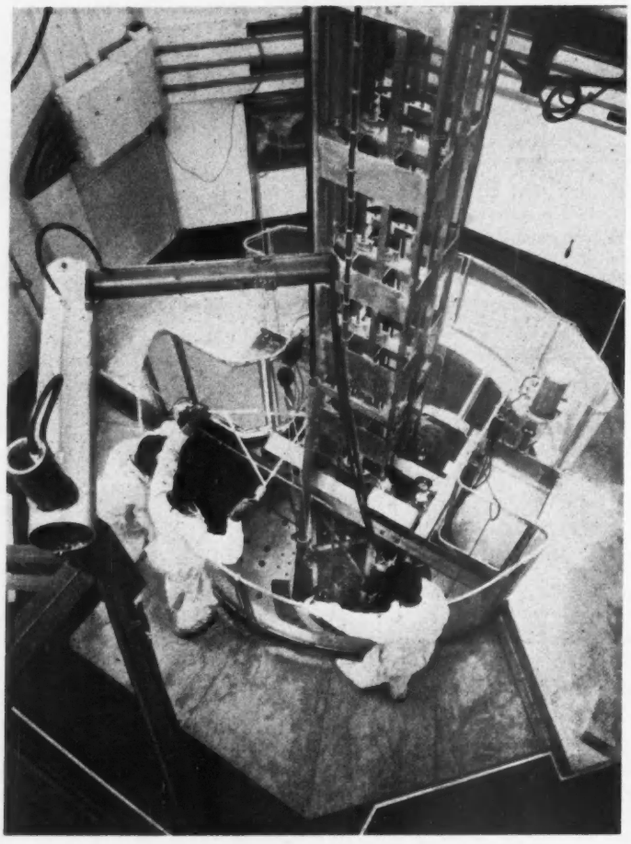


Fig. 1—"Merlin" reactor tank. A fuel element is being loaded into the reactor core

Loading of fuel elements into "Merlin" began on July 6, criticality was reached on July 16 and proving trials are now in progress, involving thermal, mechanical, electrical and other physical measurements. As these trials continue the reactor power will be gradually increased until the nominal maximum of 5MW is reached within about a year. A great deal of preparatory work on the core design has been done on a sub-critical assembly to provide confirmation of calculations of critical mass, neutron distribution, and the effect of absorbers and of temperature change. This experimental work gave values of critical mass within about 0·1 per cent of the true value.

We may mention, in passing, that the laboratory containing the sub-critical assembly also houses an experimental rig for the determination of standard neutron flux.

"Merlin" is designed to generate a large maximum fast (1MeV) neutron flux per unit of power. The maximum unperturbed fast flux with 3·4 kg of ^{235}U in the core is 6×10^{13} per square centimetre; the average fast flux in the nuclear power reactors being built for C.E.G.B. is about 10^{12} per square centimetre. Because it is the fast neutrons which contribute a large part of any irradiation damage to materials in a reactor it should be possible to carry out life tests on materials subject to radiation in power reactors.

The critical mass of the reactor core as used in the approach experiments was about 2·7 kg of ^{235}U, from which the mass of ^{235}U required to provide a reactivity of 0·055 is calculated to be about 3·4 kg. With a beryllia reflector, 3in thick, added around the vertical sides of the core the corresponding masses of ^{235}U are estimated to be 2·18 kg and 2·87 kg respectively. The maximum reactivity of the core has been limited to 0·055 for safety reasons. The maximum unperturbed thermal neutron flux with 3·4 kg of ^{235}U in the core is 5×10^{13} per square centimetre; the average thermal flux in the C.E.G.B. power reactor is about 2×10^{13} per square centimetre.

The main tank, which contains most of the water coolant and moderator, is a cylinder 11ft 6in diameter by 13ft 9in high made of high-purity aluminium $\frac{3}{8}$in thick. Below, the tank narrows, through a conical section to a lower cylinder 5ft 6in diameter by 16ft 3in high. This lower cylinder contains the experimental holes. The bottom of the tank is about 2ft below ground level.

Around the core there is a radiation shield of concrete. For the first 14ft above floor level the shield is 6ft 1in thick and for the next 14ft it is 3ft 6in thick. Up to 16ft 6in above floor level the shield is of barytes concrete (3·5 grammes per cubic centimetre). There is a 4in thick thermal

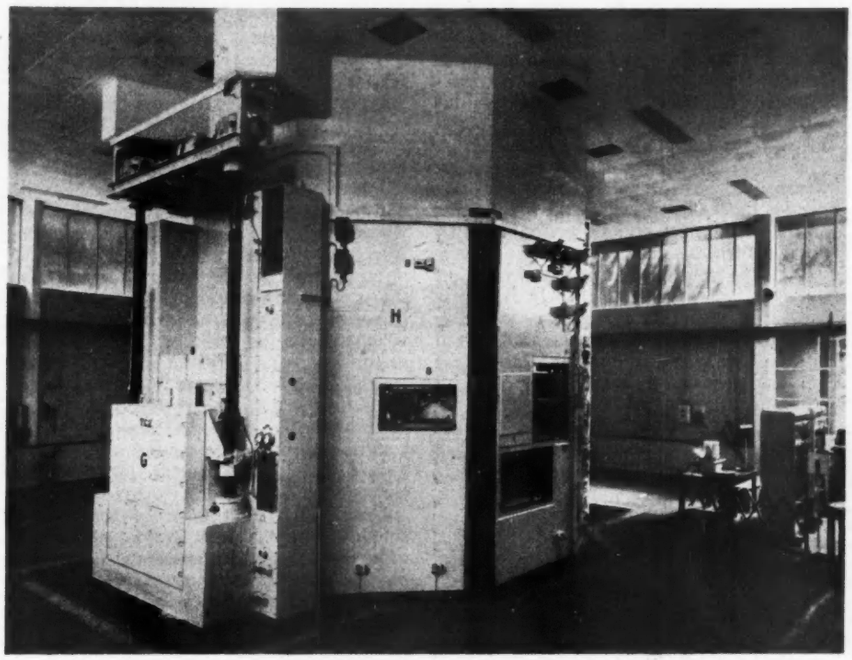


Fig. 2—" Merlin " reactor and its experimental arrangements as seen from the experimental floor

shield of lead between the lower part of the tank and the surrounding barytes concrete. This thermal shield is water cooled.

An unusual provision is that the core can be moved vertically into any one of four positions. In the top position fuel elements or experimental equipments can be loaded or unloaded. There are two intermediate positions in which the core adjoins experiment holes in the reactor shielding. The lowest position is intended for storage of the core, for example at week-ends ; this part of the tank is below ground level and the risk of loss of water is minimised.

The core is attached to the lower end of an aluminium framework which is raised or lowered by a motor-driven winch installed just above the water level. A general view of the top of the reactor showing the structural framework and the power-operated hoist and manipulator for fuel element handling, can be seen in Fig. 1 : a fuel element is shown being loaded into the core. This illustration shows, to the left of the core, part of a sector-shaped cavity for the storage of fuel elements.

Each of the fuel elements consists of fourteen parallel plates of uranium-aluminium alloy sheathed in aluminium and arranged in an open-ended box with an active length of 23½in and a cross section of 2⅞in by 2⅞in. Seen in plan the plates are dished to allow for expansion without distortion. The core lattice provides for a maximum of forty-nine elements (seven rows of seven) and twenty elements constitute critical loading. Each element is provided with a neutron source of Sb-Be.

To accommodate control rods there is a gap of ⅜in between successive rows of fuel elements. The control rods are of cruciform plan section and consist of cadmium sheathed in stainless steel.

There are two safety rods, one coarse control rod and one fine control rod. Each safety rod and the coarse rod is independently capable of controlling slightly more than the built-in reactivity. The coarse control is driven in and out by a constant-speed motor. The fine control is driven by a variable-speed motor. Emergency tripping is by gravity with spring assistance.

The experimental arrangements are as follows. In the upper experimental position there are :

(1) A central vertical hole in the core, measuring 3in by 3in by 24in.

(2) Two vertical tubes of 3in by 6in section close to and parallel to the core face.

(3) Four horizontal beam tubes, 6in diameter.

(4) Two straight horizontal tubes, 6in diameter, passing through the reactor close to the core face.

(5) A shelf to carry a specimen up to 18in cube close to the core face.

In the lower experimental position there are :

(1) A central vertical hole, 3in by 3in by 24in in the core.

(2) Two horizontal thermal columns 8ft long by 4ft 6in square, at opposite faces of the shield.

(3) One horizontal beam tube, 12in diameter.

(4) Three horizontal beam tubes, 6in diameter.

The motor-driven operating mechanism of the thermal column doors can be seen in Fig. 2.

The primary water which serves as coolant and moderator is circulated by a pump, downwards through the core. There is a flume surrounding the core and there is an anti-syphon trap in the outlet pipe from the bottom of the tank. Accordingly, the lower (core-storage) part of the tank cannot be drained of water by a leak in the experimental holes or pumping plant.

From the outlet the water is taken to a 100-second delay tank outside the reactor building and is then circulated through a water/water cooler and pumped back into the tank. The primary flow is effected by two 800-gallon per minute electrically driven pumps ; a standby diesel-driven pump is being installed. Part of the primary flow is bled off for purification, 1000 gallons per hour being filtered and 150 gallons per hour being demineralised by ion exchange.

The secondary water circulated through the coolers is drawn from Aldermaston lake and is handled by two 900-gallon per minute electrically driven pumps in a separate pump house. Another building nearby contains the filtration and ion exchange plant. There is also a change room and health monitoring centre.

Up to a height of 15ft the reactor is enclosed by a sixteen-sided brick building which is large enough to allow an experimental area surrounding the reactor and extending 22ft from the reactor face. Above the 15ft level the reactor is enclosed in a steel-framed structure with glass and aluminium cladding, giving an inside height of

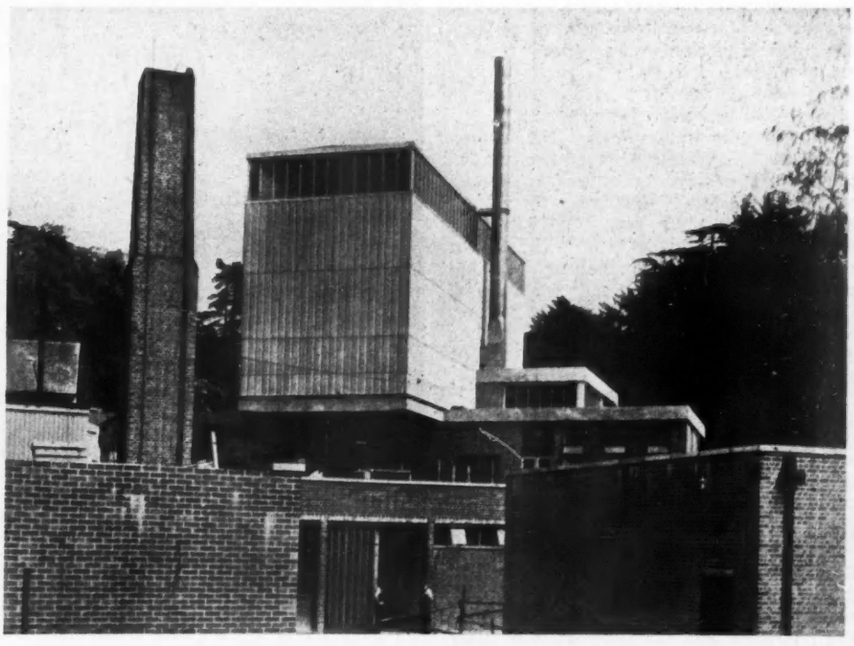


Fig. 3—" Merlin " reactor building. In the foreground are the primary coolant plant house (centre) and the sub-critical laboratory (right)

50ft above floor level. There is a 10-ton travelling crane and it has access to an unloading bay outside the building. The experimental area is overlooked by windows in a conference room and a control room at ground floor level.

Controlled ventilation is provided throughout the building, and all the air is filtered (to remove 99 per cent of particles of 1 micron diameter) before being exhausted through the stack (Fig. 3). The system is designed to change the air in the main building five times per hour, in the beam holes five times per minute, and to scavenge the space above the water level in the reactor, to remove hydrogen and radioactive gases. The air entering the building is also filtered, the specified performance being the removal of 90 per cent of particles of 1 micron diameter.

There are twenty fixed radiation monitors installed in the building and the effluent discharge system. Four more radiation monitors are placed roughly symmetrically around the reactor and several hundred yards from it to give warning in the event of any undue release of airborne radioactivity.

"Merlin" forms part of the reactor section of the A.E.I. laboratories at Aldermaston under the director of research, Dr. T. E. Allibone. The reactor section, together with the thermonuclear and nuclear physics sections, constitute what is known as the nuclear science group led by Mr. D. R. Chick. Dr. A. J. Salmon is the section leader in charge of the "Merlin" project. Site layout was by Mr. J. N. Barnett, the laboratory supervising engineer, with Messrs. Atkins and Partners acting as consultants.

Atomic Energy Report

THE fifth annual report of the United Kingdom Atomic Energy Authority covers the year ended March 31, 1959. The main events of that year included the commissioning of the last of the four Calder Hall reactors and the first Chapelcross reactor. At Windscale work was started on the building of the advanced gas-cooled (A.G.R.) prototype, and of the zero energy reactor "Hero," which will be used to complement the work of the A.G.R. It was decided to close down and seal the Windscale piles, Nos. 1 and 2. At Winfrith work proceeded on the installation of "Zenith" (THE ENGINEER, August 7, page 43); work continued on the effluent pipeline and an apprentices' school and hostel were opened in September, 1958. No decision was reached about the proposal to move the whole of the controlled thermonuclear project from Harwell to Winfrith Heath.

An agreement was signed for co-operation between the United Kingdom and Euratom and bilateral agreements were also concluded by the United Kingdom with Japan and Portugal. An agreement for the exchange of a variety of nuclear defence information was made between the United Kingdom and the U.S.A. Close collaboration on weapon development by the two countries is thereby made possible, and there is provision for machinery and fuel for a nuclear submarine prototype to be bought from the U.S.A.

In the year under review the United Kingdom A.E.A. staff increased from 30,341 to 35,260. The Authority's estimates presented to Parliament for 1959–60 were for a total of £92,433,010, which was £13,319,010 less than for the previous year. The report states that increased expenditure, including salaries and wages and grants to the National Institute for Research in Nuclear Science, were more than offset by increased receipts under appropriations in aid and reduced expenditure on works, plant and machinery.

Reactors Under Construction

Fast Reactor.—As a result of increased effort on the fast reactor at Dounreay (illustrated here) construction was completed and the reactor was handed over to the operating group in December, 1958. Commissioning was in progress, with electrical and mechanical testing of controls and instrumentation. Charging of the liquid metal circuits with sodium-potassium alloy was almost completed and the fuel elements in the breeder blanket had been completed. Core element loading followed and the approach to criticality is now nearing completion.

A.G.R.—Preliminary work on the prototype advanced gas-cooled reactor at Windscale began on October 1, 1958. The 34ft excavation, the main foundation raft and the floor plates below the main biological shield were completed.

A supporting programme of irradiation experiments is expected to begin to yield information from the autumn of this year upon topics such as the behaviour of beryllium-canned uranium-oxide fuel and on the procedure for minimising loss of moderator graphite by conversion to CO in the CO_2-graphite reaction. It will be possible to apply the results of this work to the prototype A.G.R. and its fuel. Present information is that the release of fission product gases from the fuel in the helium-filled cans is unlikely to be sufficient to impair heat transfer and thus by a cumulative process to distort the fuel elements and limit their life.

Major Reactor Studies

Water-Moderated Power Reactors.—Study of the gas-cooled heavy-water-moderated reactor system has shown the advantages of using steam as coolant in a pressure tube design: heat exchangers would be replaced by evaporators of one-third the size; also because the heat-transfer properties of steam are better than those of CO_2 the pipework and capital cost of the steam-cooled heavy-water-moderated reactor should be correspondingly lower.

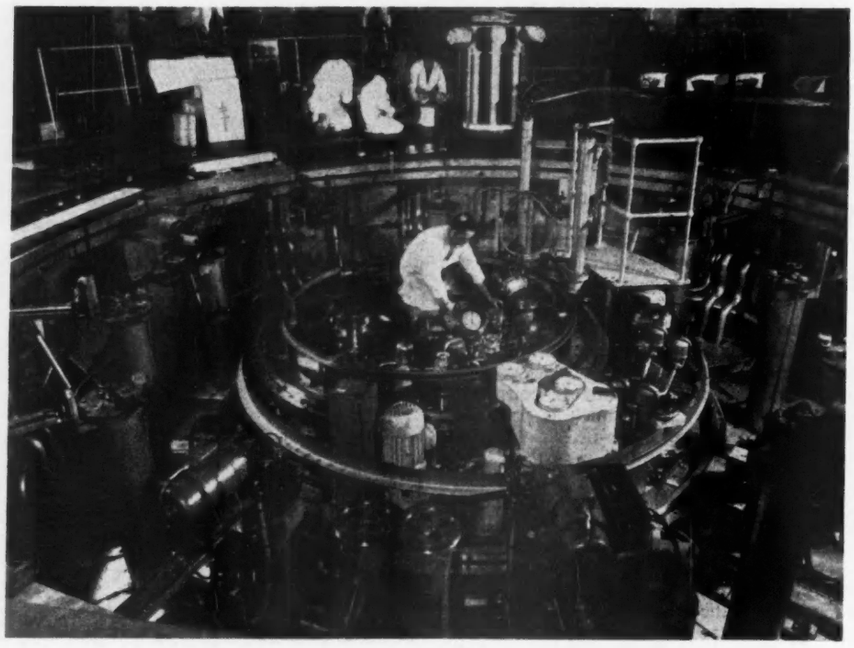
To explore the development potential of the steam-cooled system the A.E.A. has begun the study of an experimental plant which could be modified for electricity generation; an experimental 100MW(H) steam-cooled heavy-water-moderated reactor could, it is stated, be in operation by the end of 1962. This installation would include common services for a second reactor and a boiling light-water reactor (B.W.R.), for example, could be added.

Despite the advantages of the inherent simplicity of the B.W.R. and the use of ordinary water as a moderator the report points out that even with zirconium fuel cans enrichment to about 1½ per cent is necessary, which means that a large British programme of B.W.R. would need fissile materials in greater quantities and at lower costs than at present obtainable in the United Kingdom.

High-Temperature Gas-Cooled Reactor.—The high-temperature gas-cooled reactor is the subject of a joint project with other member countries of the European Nuclear Energy Agency. At present the main emphasis is on a reactor using graphite for both moderator and container of the fissile material.

Because of the containment function, progress hinges partly on the development of new kinds of graphite. Good progress has been made with the production of samples of high density graphite (in an experimental plant at Harwell) and with methods (on outside contracts) of making graphite impervious to gases and fission products.

In this reactor experiment there is provision for a gas stream for removing fission products



Fast breeder reactor at Dounreay: the top of the reactor pressure-vessel. The reactor is due to begin low-power tests shortly

from the surface of the fuel to enable various kinds of fuel elements to be tested in the reactor experiment.

Organic-Liquid-Moderated Reactors.—Because of the possibilities of organic-liquid-moderated systems for small reactors, the A.E.A. has done some basic work on the stability, under irradiation, of organic materials likely to serve as organic moderators and coolants.

Research Reactors.—The new high-flux reactor "Pluto" at Harwell began operation during the year; the power was raised in stages to 10MW(H), and tests were made to study the possibility of increasing the power to 15MW(H). The other high-flux reactor, "Dido," continued to run at 10MW(H). New hollow fuel elements were developed for use in "Dido" and "Pluto."

The materials testing reactor (D.M.T.R.) at Dounreay was commissioned and became critical in May, 1958. The reactor has since been brought up to its full power of 10MW(H) and the first experimental rigs have been installed.

A light-water-moderated system, "Eureka," intended for experiments on approach to criticality, was nearly completed. It will be a flexible assembly with provision for considerable variations in the ratios of moderator to fuel and of canning material to fissile material. To enable temperature coefficients to be measured, it will be possible to raise the water temperature in "Eureka" to 80 deg. Cent.

Controlled Thermonuclear Reactions*

The object of research into controlled thermonuclear reactions is to heat isotopes of hydrogen to such high temperatures that their nuclei acquire sufficient energy by random thermal motion to join together when they collide, forming new and heavier nuclei and releasing energy in the process. At these high temperatures all matter is gaseous and consists of positive ions and negative electrons in equal concentrations and so is electrically neutral and highly conductive. The name plasma has been given to matter in this form. Much remains to be learned about the properties of plasma. Present research is directed to studying ways of forming, containing and heating plasma and to diagnosing the behaviour of the constituent particles under a variety of conditions.

"Zeta" I and "Sceptre" III and IV.—The fourth annual report of the U.K.A.E.A. referred to experiments at Harwell on "Zeta," a ring-shaped apparatus in which deuterium gas is heated to high temperatures. The gas, initially weakly ionised, forms the single secondary turn of a transformer: when an electric charge stored in a condenser bank is discharged through the primary of this transformer, a large pulse of current (up to 200,000A) is induced in the gas, causing it to be heated to temperatures in the region of 1,000,000 deg. Cent. and so to become a plasma. This type of gas discharge is called a pinched discharge, because the gas is compressed inwards by the electromagnetic forces of the current and thus moves away from the walls of the tube. Reference was also made in the fourth annual report, paragraph 145, to a similar but smaller apparatus, "Sceptre" III, which was built, with assistance from the Authority, at the laboratories of Associated Electrical Industries, Ltd., at Aldermaston Court. A more complete understanding of the processes occurring in "Zeta" and in "Sceptre" III is necessary, and experimental work on them continued during the year.

Originally the ring-shaped tube, or torus, of "Zeta" was fitted with a liner consisting of forty-eight aluminium sections separated from one another by "Teflon" insulators, but trouble was frequently encountered from arcing between the liner sections. A continuous stainless steel liner has now been fitted, as a result of which the apparatus is much more reliable. Fitting this liner, together with other minor modifications, has led to an improvement in the purity of the gas in the torus. Modifications have also been made to the electrical circuit so that larger currents can be passed through the gas without increasing the electrical energy stored in the condenser bank. Observations have been made using currents up to 270,000A A new condenser bank has been installed, capable of delivering ten times as much energy as the original.†

Measurements of the electrical characteristics of "Zeta" and "Sceptre" III, of the microwave noise and other radiation emitted, of the neutrons, protons and X-rays produced, and of the magnetic field distributions, have all added materially to knowledge of the behaviour of the plasma. It has been shown that, although both photographs of the discharge and measurements of the changing magnetic field within it suggest that the current channel is confined by its own magnetic field and kept away from the walls of the torus, there is an excessive loss of energy to the torus walls during the current pulse. The exact mechanism by which this energy is being lost is not fully understood, but there is some evidence that energetic electrons are continually being lost to the torus walls and are being replaced by much less energetic ones. The main object of the present experimental programme is to discover the reason for this energy loss. The electron energy has been found to be considerably less than the energy of the impurity ions in the discharge, which, as stated in the fourth annual report, corresponds to a temperature of 5,000,000 deg. Cent. The electron temperature as determined from the microwave noise emitted, from the measured resistance of the current channel, and from an examination of the relative intensities of certain spectral lines emitted by impurities in the plasma, is only about 500,000 deg. Cent. This is an unexpected result. It had been expected that the electrons, being lighter, would acquire more energy than the ions, and that the ions would acquire energy as a result of collisions with electrons. Evidently the reverse is true.

A further discovery is that current flows throughout the volume of the current channel; there is no tendency for it to flow in a thin skin on the surface of the current channel, in the way that might be expected in a highly conducting plasma. This discovery is important because theoretical studies of the behaviour of plasma in the presence of magnetic fields in cylindrical systems suggest that only if such skin-currents are formed will the current channel be stable and not wriggle about in the tube and touch the walls from time to time. Instabilities of this kind lead to serious losses of energy from the discharge.

X-rays have been detected which have been produced by collisions with the torus walls of electrons accelerated to high energies. In certain circumstances electrons can "run away"; the more they are accelerated the less likely they are to make a collision and lose their energy, and they may acquire large energies before being lost to the torus walls. There is some evidence that these run-away electrons could be a cause of instabilities in the current channel.

The problem of run-away electrons can be overcome in principle by operating at higher gas pressures. To reach the same temperatures at such pressures, higher currents are necessary. An important aspect of the new capacitor bank installed on "Zeta" is that it will give the higher currents necessary for effective experimentation at high pressures. Similar conditions can be obtained in the apparatus known as "Sceptre" IV, which is already nearing completion in the A.E.I. laboratories. "Sceptre" IV has roughly the same dimensions as "Sceptre" III, but will be capable of passing currents of up to about 1,000,000A.

However, the experimental observations suggest that a more radical attack must be made on the problems of current and magnetic field distributions than can be achieved on "Zeta," and design studies have been carried out for a system‡ capable of operating both at much higher pressures and also at faster rates of current rise (to give a skin effect).

Small Scale Apparatus.—During the year there has been a considerable expansion of the work on smaller scale gas-discharge devices. To check theoretical predictions about the stability of a pinched discharge, experiments have been done with cylindrical systems, in which currents of 250,000A, rising to peak value in a few microseconds, have been passed between disc-shaped electrodes at the two ends of the cylindrical discharge tube. Skin-currents have been obtained, but the experiments are still in too early a stage for results on stability to be reliable.

Other experiments are being made on a small toroidal system with a bore of only 4in. Currents of 100,000 A, rising to peak value in 1 microsecond, have been passed in the gas, and magnetic probe measurements have shown that there is a skin-current in the early part of the pulse. There is evidence of the formation of shock waves when the plasma collapses away from the walls of the torus.

Several other straight and toroidal systems are being built, with the objectives of studying different methods of confining plasmas, the formation of skin-currents and their effect on the stability of the discharge, and the effect of pre-heating the gas so that it is more nearly fully ionised at the beginning of the current pulse. These systems will also be used to study the heating of plasmas by shock waves. In "Zeta" experiments plasmas have been heated, as an electric fire is heated, by virtue of the resistance they offer to the passage of an electric current (Joule heating), but this method becomes progressively less effective as the plasma temperature rises, because the resistance of the plasma then decreases. Consequently other methods of heating may be required to reach high ion temperatures; one of the most promising of these is shock heating, that is to say the heating produced by the passage of a shock wave travelling at supersonic speed in the gas.

Technological Development.—Some of the formidable technological problems which will have to be solved if a thermonuclear reactor is to be built are being investigated. Methods must be devised for storing hundreds of millions of joules of energy in such a

* The material under this heading is abstracted from the fifth annual report of the U.K. Atomic Energy Authority.

† The storage capacity of the condenser bank for "Zeta" I was about half a megajoule. In a practical machine this amount would be discharged in about a thousandth of a second, corresponding to an average rate of use of 500MW.

‡ This new system (The Engineer, July 31, 1959, pages 33–34) will be known as "Intermediate Current Stability Experiment" (or ICSE).

way that the energy can rapidly be injected into the reactor ; currents of several million amperes will have to be handled, and toroidal apparatus will have to be made to withstand conditions much more severe than those encountered in "Zeta." Considerable progress has been made, in conjunction with industrial firms, in the development of cheaper and more reliable condensers from which the energy can be extracted quickly and of novel types of switches suitable for the rapid switching of currents of the order of 1,000,000A. Studies have been made on storing energy in iron-cored coils (inductive storage) rather than in condensers. Inductive storage appears to be more economic than capacitative storage, but it is harder to extract the energy sufficiently rapidly for some purposes.

Other experiments have been directed to finding ways of overcoming the troubles caused by the formation of arcs between the plasma and the metal walls of the torus ; these arcs cause the metal walls to vaporise locally and so release impurities into the discharge. Small scale experiments with a liner in the form of a matrix of small, electrically isolated metal pieces have given encouraging results.

Work at the Atomic Weapons Research Establishment.—At A.W.R.E., Aldermaston, research has continued on various types of pinch discharge, using experimental scale apparatus, also with the object of achieving high plasma temperatures. As in the work discussed above, an essential requirement has been that the electrical energy from the condenser bank should be discharged into the gas discharge tube extremely quickly, i.e. in less than 1 microsecond. The problems presented by the necessary special condenser circuits and fast switches, all of low inductance, were formidable, but most of them have been overcome.

Most of the work has been done with linear discharges between two plane parallel electrodes. Two main types of discharge have been studied, known respectively as the Z and ⊖ type. In the first, the direction of the current in the gas is parallel with the axis of the discharge tube ; in the second the discharge current flows in closed circular paths round the axis of the tube. Theoretically the Z type of discharge is the more efficient as a means of heating but the ⊖ type has the decided advantage, again theoretically, that it is more stable ; both types have, therefore, been studied with the main aim of elucidating the fundamental phenomena of heating and stability.

For work on Z type discharges, specially designed fast condenser banks of modest energy have been used. One of these is "Maggie," a 1,000,000A generator storing 50 kilojoules ; this generator can provide a current with a rate of rise of 5 million million amperes per second on short circuit. Fast discharge would lead to rapid pinching in hot plasma and the aim of the work has been to investigate this rapid pinching as a means of heating deuterium gas before either instabilities or cooling by the two electrodes in the discharge tube become important. Neutrons are emitted in the discharges and their properties have been examined in detail ; it has been demonstrated that these neutrons do not arise in the more normal "sausage" instability noted in other work on controlled thermonuclear reactors. This result was reported at Geneva.

The ⊖ type discharge makes more severe demands on the condenser bank than the Z type, but nevertheless the development of low inductance banks at A.W.R.E. has proved adequate for fruitful work with this type. The stability of the ⊖ type discharge is being studied, using special diagnostic techniques, and so, too, are various features of the neutron emission observed in straight ⊖ discharge tubes when driven by a simple external conducting loop. The main effort, however, has been to understand the plasma phenomena arising during pinching and to study the longer term behaviour of the hot plasma as it is affected by various parameters, such as the degree of pre-ionisation, i.e. ionisation of the gas before the energy of the bank is delivered to it. Pre-ionisation plays a vital role in this type of discharge because it largely controls the extent to which magnetic fields are trapped within the imploding plasma sheath. The diffusion of such trapped magnetic fields through the hot plasma is a subject of considerable interest and value ; it is hoped that it may offer a useful approach to the problem of determining plasma temperature. Results of value in connection with trapping and diffusion have been obtained.

Other investigations have been concerned with oscillations of the plasma ; the period of these oscillations has been examined and a theoretical explanation of their formation arrived at. It seems possible that they may provide a means of determining the degree to which the ionised gas is collected in the sheath and they are believed to be of significance in the mechanism of plasma heating.

Experimental observations seem to bear out the theoretical expectation that the ⊖ discharge would show a good degree of stability, but to demonstrate this more satisfactorily it is necessary to use "crowbar" techniques, that is to arrange that either a short circuit is put across the discharge vessel at the instant of maximum current or that a subsidiary power source is brought into the circuit at the same instant. The effect of either is greatly to increase the time for which the large currents involved here can be maintained in the discharge vessel.

Exploratory studies of an entirely different method have been made at A.W.R.E., centring around a proposed experimental device called HITEX (high temperature experiment). The principle is that of the D.C.X. (direct current experiment) machine of the Oak Ridge National Laboratory of the United States Atomic Energy Commission, described at Geneva. The hot plasma is built up by injecting high-energy molecular ions (or neutral atoms) into the discharge vessel and arranging by some means such as dissociating the injected molecular ions, that the plasma is contained in an externally-generated magnetic field, produced by coils driven from ordinary power sources. In so far as most of the ions tending to leave the plasma will be reflected by the magnetic field back into it, the device is in effect a mirror machine of a particular type. Provided that the ions are trapped and contained in this way, a hot plasma can be built up. This approach has the fundamental feature that the problems of heating, containing and stability are largely separated, with the considerable advantage that these important aspects can be investigated more easily than when they are interdependent.

A good part of any effort in the C.T.R. (controlled thermonuclear reactions) field must consist of the solution of difficult diagnostic problems, such as the accurate measurement of temperature, magnetic field, distribution, and ion and electron densities. At A.W.R.E. high-speed streak cameras have been designed, Kerr cell techniques adapted, and time-resolved spectroscopy on the microsecond time scale developed for these purposes.

C.T.R. Advisory Committee.—In December 1958, an Authority Advisory Committee was set up (for two years initially) under the Chairmanship of the Member for Scientific Research with the following terms of reference : (i) to examine and keep under review all aspects of the Authority's research programme on controlled thermonuclear reactions ; (ii) to advise the Member of the Authority responsible for research policy on the merit of proposals for new work ; (iii) to make recommendations to the Member on changes in policy which to them seem necessary.

The membership of the committee is : Sir John Cockcroft (Chairman), Mr. J. B. Adams, Dr. T. E. Allibone, Professor P. M. S. Blackett, Professor Sir Edward Bullard, Dr. S. C. Curran, Professor B. H. Flowers, Mr. D. W. Fry, Professor M. J. Lighthill, Professor H. W. B. Massey, Dr. B. F. J. Schonland, Professor H. W. B. Skinner, Professor Sir George Thomson.

Particle Accelerators

Four new machines are in course of commissioning or construction. The largest, the 7 GeV§ proton synchrotron, is being built for the Rutherford Laboratory of the National Institute by the Authority, with a team of physicists and engineers from the Atomic Energy Research Establishment and with the constructional assistance of the Industrial Group. The energies of the accelerated particles will lie between those of the American Bevatron at Berkeley and the Russian 10 GeV machine at Moscow, but it is expected that the current in the beam will be somewhat higher than in the case of either of these machines. Construction is proceeding rapidly. The monolith concrete foundation for the 7000-ton, 150ft diameter magnet, the arched concrete roof over the magnet room, and the shield bridge, 28ft thick, which forms part of the shielding between the magnet room and the experimental area, have been completed. The major components of the machine have been designed and ordered, and production items are being delivered. Among the latter are the 20-ton magnet blocks, of which there are about 350, to be delivered at the rate of one each working day. (THE ENGINEER, May 29, 1959.)

This machine is expected to be in operation by 1962.

A second machine being built at Harwell by the Atomic Energy Research Establishment and industry for the National Institute is the 50 MeV proton linear accelerator. The three tanks of the machine have been installed and protons have been accelerated in the first tank to 10 MeV, with a reasonable current in the beam. The machine was handed over to the National Institute in April, 1959. Further developments of the machine are being considered, notably its use for experiments with polarised beams of protons and as a time-of-flight spectrometer.

Two other machines are being commissioned for use by A.E.R.E. The first is a 25 MeV electron linear accelerator, designed to produce the unusually high beam current of 0·75A, with a mean power in the beam exceeding 25kW. It is being brought into use for nuclear physics experiments.

The second new machine is one of two vertical 12 MeV tandem electrostatic generators, jointly designed by the Atomic Weapons Research Establishment, the Atomic Energy Research Establishment, and an industrial firm, for use at Aldermaston and at Harwell (THE ENGINEER, June 12, 1959, page 917).

§ 7 giga-electron-volts, i.e. 7000 million electron volts.

Agricultural Machinery

The results of the 1958 agricultural machinery census for England and Wales have recently been published. They reflect the progress that continues to be made in farm mechanisation and give a good indication of what may be described as prevailing trends in the machines now required for work on the land.

THE Ministry of Agriculture's annual census of farm machinery in England and Wales provides an interesting survey not only of the quantity but also of the variety of the equipment used in present-day farming. Last year, for example, there were nearly 40,000 combine-harvesters in use in this country, an increase of approximately 5000 over the preceding year. In the same period, the number of reaper-binders declined by 5000. There was a similar increase in the number of pick-up balers in use on Britsh farms last year and a further substantial addition to the number of grain drying installations. There are two other categories in the census results in which particularly significant increases have been made in recent years. They are electric motors, of which there were nearly 218,000 in use on British farms last year, and tractor-mounted hydraulic loaders, the number of which now exceeds 51,000. This latter figure does not include hay and green crop loaders ; what it does indicate is a four-fold increase in four years in the use of mechanical handling equipment on British farms. Inevitably, the agricutural tractor " population " continued to increase last year. According to the census returns, there were 362,210 wheeled tractors of 10 h.p. and over in use in this country, a large proportion of them being diesel-engined machines. The number of crawler tractors, 17,140, was slightly less than that returned for 1957. To the statistics provided by this machinery census, which is taken by the Ministry of Agriculture, there may be added the statement, made recently by the president of the National Farmers' Union, that in 1957–58, British farmers spent over £212 million on machinery. When it is borne in mind also that last year's exports of British tractors and farm machinery reached a total value of nearly £100 million, it is quickly realised that agricultural requirements now represent an important part of the British engineering industry's achievements.

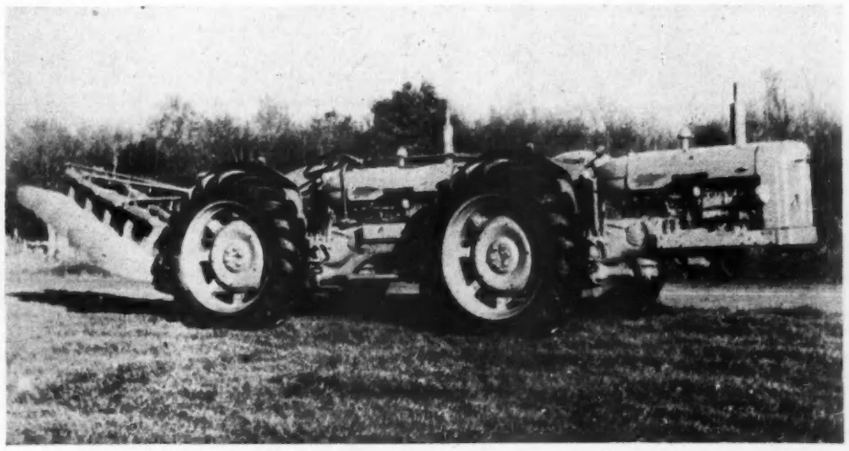
An event like the Royal Agricultural Society's annual show, which this year was held at Oxford (THE ENGINEER, July 10), provides a good opportunity for assessing the progress of farm machinery development. Much thought has been given during recent months to the future of the Royal Show. Many a time it has been urged that a permanent or two or three " semi-permanent " sites should be selected for it rather than that it should be staged in a different place every year. Arrangements have already been made to hold the next two Royal Shows (1960 and 1961) at Cambridge and the council of the Royal Agricultural Society has now decided to look for a permanent base for the show in the Midlands. Whatever the result of this decision may prove to be, it is fair to say that since the first Royal Show was held—at Oxford in 1839—the machinery display has always had an important place. In the years since the second world war, years in which great impetus has been given to agricultural mechanisation, the exhibition of machinery at the show has taken up more acres than ever. A walk along *all* the machinery avenues can be a fatiguing exercise !

In so large a machinery display, it is not always easy to discover the new developments. But, always, there are some. This year, among the tractors, for instance, there were one or two equipped with hydrostatic transmission, the development of which is now being studied with a good deal of interest. It has been suggested that this form of transmission is more likely to be applied, in the immediate future, to industrial tractors and earth-moving equipment than to purely agricultural tractors. In recent months, however, Dowty Hydraulic Units, Ltd., Ashchurch, Glos, has fitted its " Transmatic " drive (THE ENGINEER, December 19, 1958) to a Fordson " Major " tractor. Another example of hydrostatic transmission is that demonstrated by Joseph Lucas (Hydraulic and Combustion Equipment), Ltd., Birmingham. This system, which has been applied to a Fordson " Major " diesel tractor, comprises a variable capacity hydraulic pump, the output from which is taken through high-pressure steel tubing to low-speed wheel motors driving directly on to the tractor's rear wheels. These motors are connected in parallel to the pump, thus permitting them to operate at the same pressure drop and torque whilst the flow through each varies according to the required speed of rotation of the wheel. The pump and motor circuit is closed and internal leakage is returned direct to the transmission oil tank ; any loss is made up from the same tank by an engine-driven boost pump supplying to the low-pressure side of the main pump. The low-pressure side of the circuit is maintained at approximately 100 lb per square inch.

Control of the tractor is effected by the engine throttle on the steering column and the pump stroke control lever on the left-hand side of the driver's seat. Stroke control from this lever is operated by an integral servo piston which is connected directly to the camplate of the pump. A Massey-Ferguson 35 diesel tractor has also been modified to take a Lucas hydrostatic transmission. The low-speed wheel motors for this are different from those incorporated in the Fordson " Major," though the principle of operation is the same, in that the cylinders are fixed and the crank rotates.

The " Flamingo " tractor conversion gives a ground clearance of 4ft 6in

Quite apart from hydrostatic transmissions, there have lately been some interesting conversions of orthodox tractors to suit them to particular kinds of work. The " Triple D," illustrated herewith, is one example. This equipment has been assembled by Ernest Doe and Sons, Ltd., Ulting, Essex, by coupling up two Fordson " Power Major " tractors. By making more than 100 h.p. available, the " Triple D," which is four-wheel-driven, can undertake ploughing and other basic cultivation tasks on heavy land where the going may be specially difficult. As the illustration shows, the front wheels and axles of the tractors have been removed and the two are joined head to tail. The coupling is effected by using a steel turntable fitted below the engine of the rear tractor ; hydraulic rams controlled from the rear steering wheel enable the angle between the two units to be varied. The trunnion extension of the front tractor is carried, in bronze bearings, in a large diameter steel tube which is fixed to the lower member of the turntable. The tractors are thus able to oscillate at right angles to the lengthwise axis and, at the same time, maintain their ground levels. When operating the " Triple D " the driver selects the correct working gear on each tractor manually, with each high-low gear lever at neutral ; the control for the front high-low lever is brought back to a lever operated



The " Triple D " is a four-wheel-driven assembly of two Fordson " Power Major " tractors giving over 100 h.p.

David Brown "950" industrial tractor equipped with overloader for the handling of sewage sludge

from the driving position on the rear tractor. Clutch control is by a hydraulic master cylinder and a slave-ram to each clutch.

Another tractor adaptation which has been undertaken recently is one by Lenfield (Ashford), Ltd., Ashford, Kent. This equipment, known as the "Lenfield Flamingo," consists of a Massey-Ferguson 35 tractor elevated on a tubular steel frame to give a ground clearance of 4ft 6in. It has been designed for inter-row cultivation and spraying in bush-fruit farming. The wheel track is set at 6ft. The steel frame on which the tractor is mounted is carried on reinforced tubular cross bearers and the drive from the tractor is by totally enclosed chain and sprocket. In extending the tractor's front axle, care has been taken not to interfere with the normal caster camber and pin inclination angles; front wheel thrust is absorbed through stay tubes connected to the main frame.

Industrial Tractor Developments

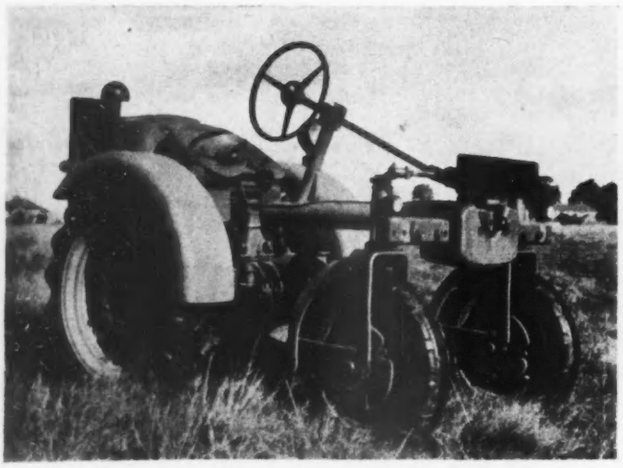
The use of agricultural tractors and other machines in industries and services outside farming is increasing. Most of the tractor manufacturers are now producing "industrial versions" incorporating various modifications to fit them for a variety of tasks. One example which has come to our notice recently is the industrial model of the "950" tractor introduced earlier this year (The Engineer, January 30) by David Brown Tractor Division, Meltham, Huddersfield. This tractor is powered by a four-cylinder diesel engine capable of 43·5 b.h.p. at a maximum speed of 2200 r.p.m. An accompanying illustration shows one of these tractors equipped for handling sewage sludge by means of a dual pivot overloader. This particular handling system, which has been evolved by David Brown Construction Equipment, Ltd., includes lifting the sludge from the bed, separating it from the surface ash and loading it to a trailer drawn by a second tractor. The overloader bucket, which is made of aluminium alloy, is 7ft 6in wide. Its leading edge is in the form of a "comb" comprising three separate sections of tines spaced at 2in pitch; each tine section is detachable. An adjustable mirror, which is fitted to the trailing edge of the bucket, allows the operator to watch the tines and thus retain precise control throughout the digging and lifting operations; the mirror is kept clean by a gravity-operated guard. The dual pivot loader has been designed for digging as well as loading and will discharge to the front or the rear as required. The loader support frames are fitted to three cross-shafts which provide a pin-jointed triangular structure, and there are two stabiliser bars which carry thrust loads to the rear axle casings. The hydraulic equipment includes a Hamworthy gear pump which is driven by the tractor engine and draws oil from a 4-gallon tank through a ¾in pipe. The oil is directed to the system by a Hamworthy control valve with self-centralising spools.

Another industrial tractor which is being introduced by David Brown Construction Equipment, Ltd., is the 2D. It is a 14 h.p. machine powered by a two-cylinder, four-stroke diesel engine. As may be seen from our illustration, the engine is rear mounted. There is a 12V electric starter and the gearbox gives four forward speeds and one reverse, the maximum forward speed being 10·5 m.p.h. The tractor is equipped with independent rear foot brakes, its turning radius is no more than 7ft 9in, and its normal haulage capacity, according to the makers, is 5 tons. The agricultural 2D tractor was first introduced in 1956; it is essentially a tool carrier designed for operating centrally mounted implements.

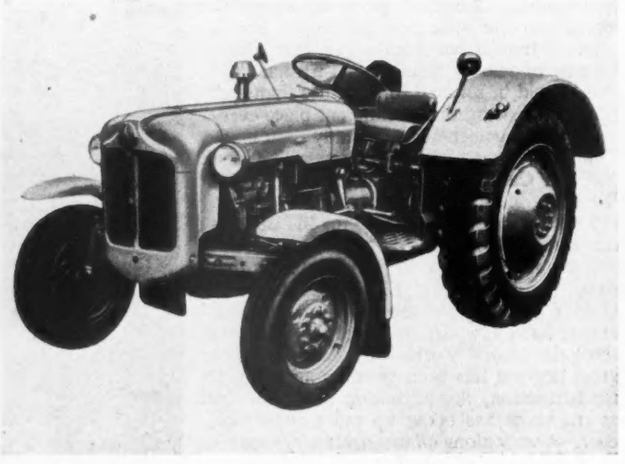
At the recent Royal Show, Ford Motor Company, Ltd., Dagenham, exhibited a "Dexta" tractor equipped for industrial and road transport. This tractor is illustrated herewith; like the agricultural version, its power unit is a 32 b.h.p., three-cylinder diesel engine. The constant-mesh transmission gives six forward and two reverse speeds, the top forward speed being nearly 17 m.p.h. The tractor has been designed to comply with the Road Traffic Acts, its details including hydraulic foot-operated brakes, a parking brake, front and rear mudguards allowing full track adjustment from 48in to 76in, twin rear view mirrors, speedometer and car type instrumentation, accelerator pedal and steering wheel throttle control. There are two models of this "Dexta" industrial tractor, the one with full hydraulics and power take-off, and the other with a heavy-duty three-position drawbar, but without the hydraulics and p.t.o.

Root Crop Machinery

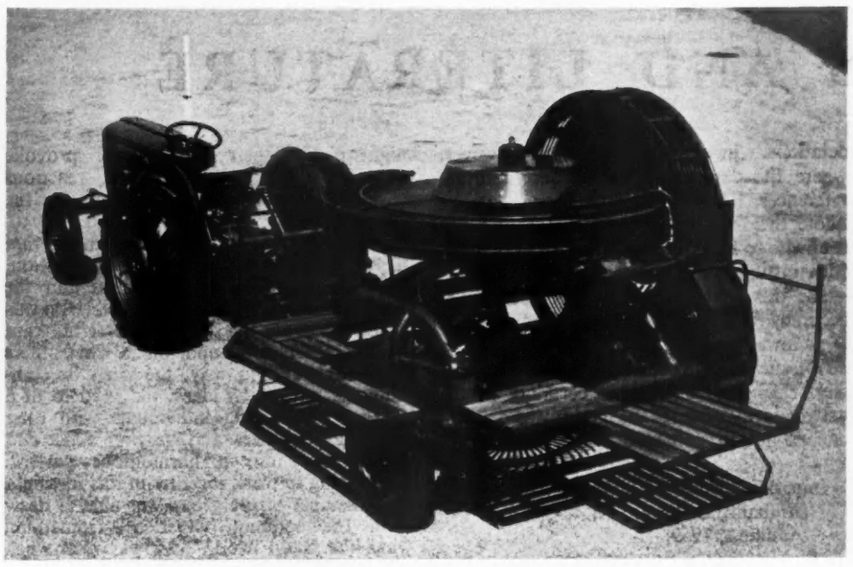
An aspect of farm mechanisation that has received considerable attention in the last decade is that concerned with the cultivation and harvesting of root crops, such as sugar beet and potatoes. There is increasing utilisation of machines for the precision drilling, thinning, harvesting and cleaning of sugar beet, all of which tasks, if done manually, call for a large labour force. The machine planting and harvesting of potatoes has not



David Brown "2D," 14 h.p. industrial tractor



32 b.h.p. "Dexta" tractor equipped for industrial and road transport services



Potato harvester, with vertical elevating drum and circular sorting table

yet reached the same proportions as mechanised beet growing, but progress continues to be made. At the recent Royal Show, a number of potato planters and potato diggers and complete harvesters were exhibited. Among the latter was a complete potato harvester which is now being made by Massey-Ferguson, Ltd. Its design is based on an experimental machine evolved by the National Institute of Agricultural Engineering.

The harvester, illustrated herewith, is tractor hauled and is driven from the power take-off ; only about 5 h.p., it is stated, is absorbed when it is in work. The machine is assembled on a tubular steel frame carried on a pair of pneumatic-tyred wheels. The depth of digging is controlled by hydraulic rams, one for each wheel, which are independently operated by a double spool valve and only about 1000 lb per square inch operating pressure is needed. An indicator, which is connected to the nearside wheel, enables the tractor driver to check on the digging depth.

The makers claim that this machine gives " gentle separation " when harvesting a potato crop. The potatoes, together with haulm and adhering soil, are lifted by a 30in diameter disc digger and deposited on a rotor consisting of a central conical portion from which steel tines radiate. A good deal of the soil falls through this rotor and, on their way round it, the potatoes are cleaned by contact with a fence of spring tines arranged around part of the circumference. From the rotor, the potatoes are deflected into a vertical elevating drum or cage, which can be seen to the right of our illustration, the deflection being effected by a conical roller with a rubber extension. As it turns into the drum, this roller strips the haulm from the potatoes, the haulm and soil being cleaned from the rotor by a two-piece scraper. As potatoes enter the elevating drum they rebound from its outer wall, which is made of canvas-reinforced rubber sheet and spring tensioned at the centre. The potatoes drop on to rubber hoses trailing in the bottom of the cage and are conveyed to the top by rows of rubber fingers which divide the drum into sections. To keep the whole of the drum free from soil there are tines which comb between these fingers and the outer cage meshes are raked by a rotating device on which rows of rubber fingers radiate from a central portion controlled by a friction clutch. The fingers clean between the cage bars and are turned intermittently as they are struck by crossbars. From the top of the drum, the potatoes are discharged on to a rotating sorting table which is made of reinforced rubber sheet. Two to four sorters, as required, stand on non-slip wooden platforms around this table to pick off the good potatoes only and drop them into a gallery. A scraper keeps the sorting table clean and discharges the rejected rubbish into a chute. The floor of the gallery on to which the good potatoes are dropped is also rotating and from it the potatoes are conveyed to the bagging unit.

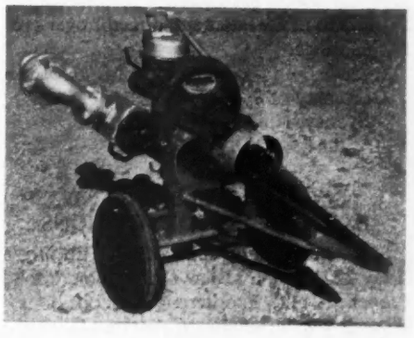
In designing this machine, careful attention has been given to operating safety. Slip clutches are incorporated on the main drive shaft, the drive to the elevating drum and on the drive to the sorting table. The power take-off shafts are fitted with safety guards and there is a chain-driven change-speed device which enables the harvester to be operated by tractors with non-standard p.t.o. speeds.

Field Irrigation

The provision of equipment for effectively irrigating fields and market gardens is another matter which is carefully studied by agricultural engineers. In recent years, most areas of this country have had a good deal of experience of wet seasons ! Nevertheless, there is still considerable scope for efficient irrigation as an aid to greater agricultural and horticultural production. In many countries overseas, of course, irrigation needs are obvious.

A short time ago we attended a demonstration of the sprinkler irrigation system designed by Wright Rain, Ltd., Ringwood, Hants. The equipment consists of a line of aluminium alloy piping with take-off valves at intervals, to which lateral lines of sprinklers are connected as required. The main pipeline is connected to a centrifugal pump which can be tractor-mounted for power take-off operation, or driven by an integral power-pack or electric motor. The lengths of pipeline are joined by a simple latch coupling and a recent innovation is an arrangement enabling as much as 250 yards of 4in diameter pipeline to be towed by tractor when it is required to take up a new position. Aluminium skid pans are attached to each coupling and the sprinkler line is towed in two halves joined by a 10ft length of hose ; a similar length of hose joins the first half to the main pipeline. This " Tow-Line " system, as it is called, may have a somewhat limited application in this country, as its principal utility is where very large acreages of pasture land need to be kept well watered.

The same company has also devised a method of distributing liquid farmyard manure by pumping it through irrigation pipelines. In addition to the field piping and a hand-operated manure thrower the " manure rain " equipment includes a collection tank, normally built of concrete, and a pump. The tank is fitted with a paddle agitator turning at about 15 r.p.m., approximately 1 h.p. being required for each 6ft length of paddle shaft. Water is run into the tank to a depth of 2ft or so. Stockyard drainage goes directly into the tank and the whole of the contents are agitated twice a day. A four-bladed cutter is also incorporated in the system to ensure that the straw in the manure is reduced to short pieces. For distributing the " manure rain " a single-stage 3in centrifugal pump has been designed by Wright Rain, Ltd. This pump has an open vaned impeller capable of taking small solids up to ½in diameter and the occasional piece of long straw. There are two versions of this pump, namely, a bare shaft unit suitable for operation by an electric motor or diesel engine and a tractor-driven unit which incorporates a speed increasing gearbox and has a conventional two-wheel trolley and universal shaft for power take-off drive. This latter version of the pump is illustrated herewith. At a maximum p.t.o. speed of 600 r.p.m. (a maximum pump speed of 1870 r.p.m.) a discharge rate of 160 gallons a minute is claimed at 128ft head.



Tractor-driven single-stage pump for field irrigation

Technical Report

Some Visual Observations of the Effects of Sweep on the Low-Speed Flow Over a Sharp-Edged Plate at Incidence. By N. C. Lambourne and P. S. Pusey, of the Aerodynamics Division, N.P.L. Reports and Memoranda No. 3106. H.M. Stationery Office. Price 14s.—Qualitative descriptions are given of the flow over a series of sharp-edged, semi-span plates having various angles of sweep and at incidences as high as 30 deg. The main interest was the type of flow resulting from separation at the leading edge and the changes that occur when the angle of sweep is varied within the range 0 deg. to 60 deg., both backward and forward.

The flow was visualised in a water tunnel both with air bubbles and with small spherical particles of polystyrene, whilst information concerning the surface flow on the plates was obtained using oil-film techniques in a wind tunnel. A few observations were also made using a tuft grid in a wind tunnel.

Attention was mainly directed to the flow over the " upper " or suction surface and in the region immediately downstream of the plate. The observations trace out the systematic changes that take place in the behaviour of the free vortex layer from the leading edge and the shape of the regions of reduced total head as the sweepback is varied.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PITTING IN GEARS

SIR,—The letter from Dr. H. E. Merritt (May 8) appears to have evoked no response or interest. Does this confirm my belief that both the scientific authorities and the scientists and research workers themselves are to-day interested only in the abstract, and are not concerned with the problems of "the common-or-garden craft based side of mechanical engineering"?

J. N. BURNS

Kenilworth,
June 24, 1959.

SPEED FACTORS FOR GEARS

SIR,—It may be of interest to know that not only the B.S. speed factors approach a log-log tangent of index $-0{\cdot}2$, as has been pointed out by Dr. Merritt, but also the AGMA speed factors. The difference between $2{\cdot}5/V^{0{\cdot}2}$ and the AGMA speed factor for spur gears $(84-\sqrt{V})/84$ is only 2 per cent in the range of 250ft to 1100ft per minute, i.e. in the speed range "where it matters." The same is the case with $2{\cdot}5/(V/2)^{0{\cdot}2}$ and the AGMA speed factor for helical gears $78/(78+\sqrt{V})$ in the range of 1000ft to 8000ft per minute. No other index appears to fit the latter speed factor over such a wide range.

M. BOOMSMA

University of Sydney,
Sydney, N.S.W., Australia,
June 5, 1959.

SOLID PROPELLENT AND EXOTHERMIC COMPOSITIONS

SIR,—In a recent issue of THE ENGINEER (May 22, 1959), a review of my book "Solid Propellent and Exothermic Compositions" appears with a number of comments on the spelling of the word "propellant," which I think need a little explanation from me.

For some years now it has been standard in the explosives industry to use "propellant" as a noun and "propellent" as an adjective. When this is realised, I think it will be seen that the variations referred to are natural and understandable. For example, the reviewer has actually mis-spelt the title of the book. In the title "propellent" was used as an adjective following very careful discussion with the Editor. I agree present usage is open to criticism, but I felt I had to follow it.

Another comment I would like to make is about the variation in units. This is an extremely difficult matter, and I decided to retain those units normally employed in the subject matter dealt with in any section. The units used in rocketry, for example, and in ballistics are normally different from those used in theoretical chemistry. In so far as the data has been derived from work in my own organisation, I have tried to have uniformity, and this has involved many weeks of work for Miss J. M. Davidson and others who have carried out the calculations. In a number of cases, however, where the data are derived from literature references, I have thought it appropriate to quote them as they are, since I considered it unwise to have them recalculated—perhaps with insufficient understanding on my part—and thereby to assume a responsibility for accuracy which is not under our control. It is always difficult to decide on what to do in such circumstances where the subject matter is very mixed, but certainly in the vast majority of cases the choice was deliberate and not due to lack of consideration.

JAMES TAYLOR

Imperial Chemical House,
Millbank, London, S.W.1,
June 8, 1959.

Book Reviews

Exploration in Group Relations. By E. L. TRIST and C. SOFER. Leicester University Press, Leicester. Price 7s. 6d.

THIS book describes the first full-scale experiment carried out in this country in a method of training which has been more fully worked out in America. We, in this country, have come rather belatedly to a recognition of the fundamental importance of the human factor in industry and commerce and acceptance of it is still extremely grudging. Good employers no longer need to be persuaded that it is good business as well as good citizenship to pay a great deal of attention to the welfare of those in their employment, but that this constitutes only the first step—and by far the easiest step—in a well-run enterprise is still not understood by any but a tiny minority.

A sense of uneasiness that something is needed, though they do not quite know what, has led some firms to support modest courses in foremanship and slightly less modest courses in management; and having sent their promising young officials off they expect them to return with "the goods"—the "know-how" of dealing with their colleagues, both above and below them in the hierarchy—and leave it at that. But management, like any other human activity, does not take place in a vacuum or in isolation. It is not a question of mastering a few technical "tips" to behaviour, but of learning to understand a situation and how to cope with it; and this involves an awareness of one's own reactions and attitudes as well as those of the people whom one meets.

"Know thyself," said the philosopher and this is what the laboratory method of training in group relations helps the participants to do. In this first experiment small groups of people drawn from many different types of work—industrial, commercial, professional, social service—lived together for a fortnight at Leicester University, chosen because the project was being organised jointly by certain departments of that university and the Tavistock Institute of Human Relations. By constant discussion of problems and "situations" they gradually learned something of the nature of co-operation in a common task, of how decisions are taken and the roles played by different members of the group in reaching them and in carrying them out. With the aid of the consultants and observers they began to appreciate the ways in which their own emotional reactions might distort their judgment or provoke contrary, and equally irrational, reactions in another member taking part in the discussion.

Every kind of work, except, perhaps, that of the artist working in complete isolation, involves co-operation with others and the fundamental problems associated with this co-operation are the same whatever the kind of job; the need to understand what others are getting at and why, the need to communicate one's own ideas, the need to fit a number of differing individuals with their own sharp corners and varying skills and personalities into a harmonious pattern. By learning to work together in this fortnight each member of the group was able to draw from the common experience something which he could use in his own work when he went back. But perhaps best of all he began to appreciate in the words of Dr. J. S. Sutherland, one of the consultants to the course, "that there are few, if any precise rules for handling others. There are no gimmicks and no short-cuts."

This book gives a short and sensible account of the experiment and of the follow-up of those who took part in it. All seemed to have benefited from their greater appreciation of the nature of group forces and from the recognition of the part played in group relations by their own emotional attitudes. Further experiments along these lines are so urgently needed that it is a pity that the reporters of this first one—Mr. Trist and Dr. Sofer—did not give rather more details about some of the problems discussed and the lines taken by the group discussions. The account is so abstract and so detached that it is difficult for those who are unfamiliar with this kind of thing to understand just what happened. One or two accurate, and lively, descriptions of actual group discussions would have proved extremely illuminating.

Philosophy of Structures. By EDUARDO TORROJA. English version by J. J. Polivka and Milos Polivka. University of California Press. University of Cambridge Press, Bentley House, 200, Euston Road, London, N.W.1. Price 94s.

TORROJA's name is well known to most European engineers, particularly for his work in reinforced concrete. In this book he considers the whole subject of structural engineering in its widest aspects. No analyses or mathematical solutions are given—the text is purely descriptive. This is refreshing although just occasionally one longs for the economy of mathematical symbols.

It performs a useful function in that it describes the forms of structures that have been used to resist the various forces and loads which occur, and it enables the reader to appreciate the structure as a whole rather than in parts. It is pleasant, too, to have the many materials available to engineers discussed in an impartial manner, and no attempt is made to write up one material at the expense of another.

The book is divided into four main parts: in the first the basic materials, both classical and modern, are described; in the second, the basic forms of resisting structures such as arches and beams; in the third, parts or the whole of the structure such as

floors and bridges ; and finally in the fourth part the approach of an engineer to his basic problems is considered.

On the whole the material is sound and most aspects of structural thinking that are important are covered. For this reason the book should be particularly useful to those students of the subject who have not had the time or opportunity to amass this experience for themselves. To the more experienced engineer the later chapters, i.e. the fourth part, will be of more value since it is always interesting to have the views of an eminent engineer in his approach to the subject.

There are several points of detail which may be criticised. It is stated that the expansion coefficients of concrete and steel are significantly different and that it is cheaper to use concrete than steel for compression in beams. The section, too, on prestressed concrete is, surprisingly, rather confusing. Perhaps the most serious criticism is, however, that it is not an easy book to read since the language is stilted and words like " archivolt," and expressions such as " aesthetic hysteres " are unhappy choices in this respect. Nevertheless if one is not put off by the occasional idiosyncrasies of the wording the book gives a useful viewpoint of the subject from a very experienced engineer.

The Physical Metallurgy of Magnesium and its Alloys. By G. V. RAYNOR. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 75s.

FOUR other titles have appeared in this International Series of Monographs on Metal Physics and Physical Metallurgy. They dealt with " Metallurgical Thermochemistry," " The Theory of Cohesion," " Thermochemical Data of Alloys," and " Lattice Spacings and Structures of Metals and Alloys." The author of this fifth book is the editor of the series and since his book went to the printers he has been elected a Fellow of the Royal Society, so one should now add M.A., D.Sc., F.R.S., after his name.

The 531 pages of this volume contain 226 illustrations, and most of these are line diagrams which attempt to picture the atomic arrangements of the crystal structures of a multitude of alloys of magnesium. As one should expect from the title and from the fact that the author worked with Hume-Rothery at Oxford, most of the topics discussed are included in what is called " Metal Physics." It would be difficult to say where the dividing line should be drawn between metal physics and physical metallurgy but it is now clear that the coming generation of physical metallurgists will be expected to understand and to make use of much that was, only a few years ago, known as metal physics. Engineers will find all but the first and last of the seventeen chapters of this book difficult to comprehend as practical matters about which they can take action. Nevertheless they are matters which will have to be studied by physical metallurgists if we are to make the best use of the very abundant supplies of magnesium which exist on land and in the sea.

The seven pages of the introduction will be appreciated, but those who remember the advent of the magnesium alloys as commercially useful engineering materials will be amazed that it is possible to write a book such as this, without reference to the metallurgical saga of the production of the famous " Elektron " group of magnesium alloys containing over 85 per cent magnesium and varying amounts of aluminium, zinc and manganese. Developed into commercial materials for the first time in the Ruhr they were brought into use in this country by the hard work of Mr. E. Player before 1930. In those days he lectured in Birmingham on the Elektron alloys of magnesium ; as neither his name nor the word Elektron appear in the index it must appear that the gulf fixed between physical and industrial metallurgists still needs to be bridged.

Detailed discussion of the general mechanical properties and the technology of industrial alloys is beyond the scope of this monograph, although in certain cases the alloys discussed give rise to useable materials. However the literature on the mechanical properties of magnesium and its alloys is extremely voluminous, and therefore difficult to summarise adequately. But that is exactly what practical engineers need. If their eyes are dazzled by a mass production of scientific brilliance they will not have their attention focused on to the alloys which they should use and the precautions which it appears are essential in their employment.

In recent years several books and a large number of scientific papers have been written about magnesium and its alloys. This book differs from all the others in that it concentrates upon reviewing what may be called the more theoretical aspects of alloy formation in magnesium and it analyses what is known about potentially useful alloys from that point of view. New casting alloys containing zinc and zirconium have better tensile properties than the older alloys, by reason of the attainment in casting of a very small grain size. Cast magnesium alloys can hold their own with cast alloys of aluminium. So far the best has not been produced commercially in wrought magnesium alloys and they are not yet up to the standard, for many applications, of the established aluminium-base alloys. This monograph should contribute to a better understanding of the problems involved.

First Steps in Heat Transfer. By J. SMALL. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 12s. 6d.

IT is rare to find an author who can resist the temptation to pack into his book more material and references than his readers can use. Professor Small is such an author ; the result is a finely judged and well-written booklet which will be of great value to engineering students beginning the study of heat transfer. The topics covered include conduction through composite slabs and cylinders, dimensional analysis of convective heat transfer, simple heat exchanger analysis, and an introduction to radiative transfer. Students of mechanical and chemical engineering will, of course, have to turn to more advanced texts before graduation, but the present book is very suitable as a first course. There are some very minor criticisms to be made. For example, the Fourier equation (wrongly named the Laplace equation in the book) is written with the symbols for ordinary rather than partial differentiation ; and the particular solution which is given should have been referred to as *a* solution rather than *the* solution. Such small misstatements can lead to confusion later. Again, on successive pages the symbol *H* is used for two quantities of different dimensions. Finally, though the term " enthalpy " has now, for sound educational reasons, almost everywhere replaced the older term " total heat," Professor Small has not yet followed the fashion. Since this excellent book is sure to be widely used, it is reasonable to hope that these small blemishes will be removed in later editions.

Le Calcul Analogique par Courants Continus By MONSIEUR DANLOUX-DUSMESNILS. Paris : Dunod-Editeur, 92, rue Bonaparte, Paris (6e). Price Fr.2850.

DIRECT-CURRENT analogue computation can solve systems of differential equations, whether linear or not, with great facility and a good degree of accuracy. The method can therefore be applied to a very wide range of phenomena, such as mechanical and electrical vibrations, including the behaviour of systems with several degrees of freedom, hydraulic and aerodynamic research, cybernetics, and servo-mechanisms. Other scientific fields where its value has proved itself are structural theory, heat transmission, nuclear reactors, and the study of elementary particles in electric and magnetic fields. The idea of " simulation," again, has been applied not only to problems of piloting aircraft, but also to those of biology and even of economics. The present book gives a comprehensive account, using a minimum of mathematical equipment, of the principles and applications of analogue computation.

Landwirtschaftlicher Wasserbau. By G. SCHROEDER. Berlin-Göttingen-Heidelberg: Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.54.

THE rapid development of agricultural hydraulics since the second edition of the present handbook appeared in 1950, has made necessary many changes and revisions. *Agricultural Hydraulic Engineering* is designed as a textbook for the student as well as a work of reference for the practising technologist. It deals with the main ancillary sciences, the physical, chemical and biological properties of soils, botany, hydrology, and meteorology, and then proceeds to discuss the principal structures used in connection with flood control, drainage and irrigation. Considerable space is devoted to the reclamation of moors ; the last chapter deals with the reclamation of land from the sea. Those seeking fuller information on particular aspects will find the extensive bibliography of assistance.

Praktische Hilfsmittel für Werkstatt und Betrieb. No. 6 of the TR Special Series. Berne : Verlag Technische Rundschau, Hallwag, Berne, Nordring, 4, Switzerland. Price Sw. Fr.4·20.

THE present reprints from the " Technische Rundschau " contain a wealth of ideas and improvements from the field of workshop practice which will be of interest to production and toolroom engineers. A few headings may serve to indicate the scope of this publication : marking punch for control circles, avoiding chatter marks in countersinking, specially ground spiral drills for thin sheet, jigs and fixtures, thread-cutting aid, holding tapered workpieces in a three-jaw chuck, screw-retaining screwdrivers, free-wheel turning mandrel.

Books Received

Pratique de la Mesure et du Controle dans L'Industrie. Vol. 2. By J. Burton. Dunod Editeur, 92, Rue Bonaparte, Paris (6e), France. Price Fr.4,600.

Gas Fitting (Intermediate). By D. M. Holloway. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 21s.

Seventh Symposium (International) on Combustion. Butterworths Scientific Publications, 4 and 5, Bell Yard, London, W.C.2. Price 224s.

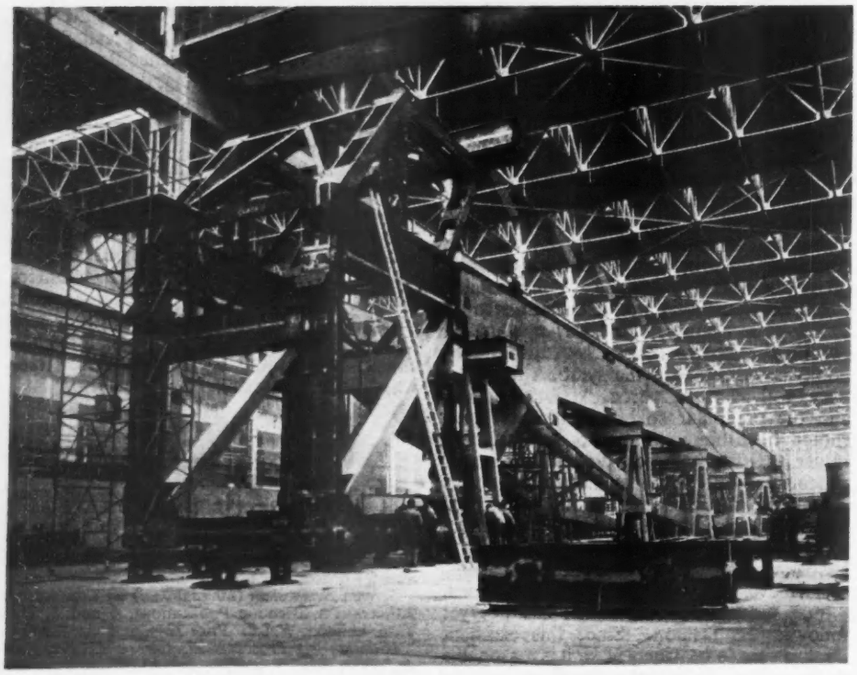
Initiation aux Processus Aleatoires : Le Processus de Poisson Files D'Attente—Pannes de Machines. By M. Girault. Dunod Editeur, 92, Rue Bonaparte, Paris (6e), France. Price Fr.980.

400-Ton Goliath Crane at Hinkley Point

A Goliath crane which has been installed for the construction of the Hinkley Point nuclear power station has a capacity of 400 tons and an overall height of 240ft, with a span of 250ft between the legs. This crane, to be seen in the illustration on the right, is designed to traverse over a distance of 500 yards to transport units from a plant fabrication area to the main reactor building on the site. It is of unit construction and designed for dismantling and transport to other sites when the Hinkley Point station is completed.

WHEN the project for the construction of the 500MW nuclear power station at Hinkley Point was under consideration by the English Electric, Babcock and Wilcox, Taylor Woodrow group it was decided to install a Goliath crane capable of handling the heaviest loads envisaged in the building of the reactor groups and their associated steam-raising plant. It was planned to fabricate the plant on an adjacent assembly area and use the crane to transport it to the site of the power station. The maximum load which would have to be handled by such a crane would be the shells of the steam-raising units, each weighing some 385 tons and nearly 90ft long by 22ft 6in diameter. The crane would be required to travel a distance of over 500 yards and have a sufficient height and span to straddle the reactor buildings and clear them with its largest load. These conditions fixed the span of the crane at 250ft (between centres of track rails), and the maximum height of lift (from hook to ground level), at 200ft, with a maximum load capacity of 400 tons.

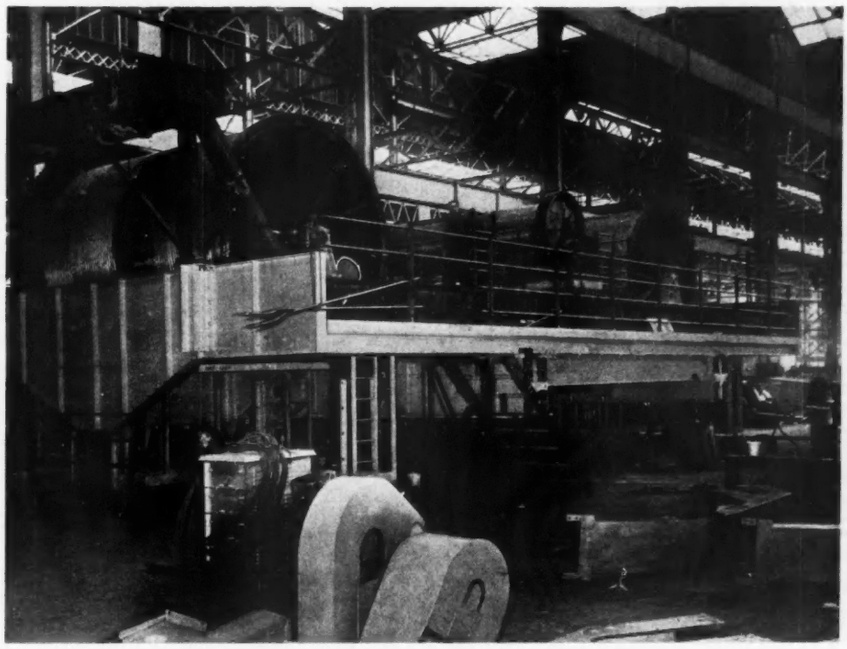
When the requirements of the crane had been determined its construction was placed in the hands of Babcock and Wilcox, Ltd., and in the final design the firm worked in collaboration with Freeman, Fox and Partners, the consulting engineers. The crane, which was completed recently, is stated to be the largest of its kind yet built. With its overall height of 240ft above ground level and span of 250ft between the legs, it can straddle and clear adequately the 180ft high reactor buildings. Loads up to 400 tons can be raised on two 200-ton lifting hooks at a speed of about 4ft per minute. Each hook is suspended from a separate crab complete with its own hoisting gear and control cabin, and the hooks can be operated independently or synchronised for control as a single unit when handling the heaviest loads. When carrying a load of 380 tons the crane travels at speeds up to 50ft per minute.



General view of completely assembled bridge girder at maker's works

The crane has been so designed and built so that it can be dismantled for transport by road, rail or sea for re-erection and use on other constructional undertakings. For this reason the 250ft long main girder or "bridge" and the 240ft high bipod legs are built in sections of convenient size and bolted together. The general design of the crane can be seen in the illustrations showing it under construction in the maker's Dalmuir works, and its main details are given in the drawings reproduced.

In the bridge each of the two main girders carrying the crabs comprises a box girder forming the top boom and tension links which form the bottom boom, the tension links being connected to the box girder by vertical struts. The 9ft deep by 3ft wide box girders are of welded plate construction with plates of high-tensile structural steel. Each girder is made in five sections, with accurately machined ends to ensure good bearing faces between adjacent sections. These sections are connected together by large diameter high-tensile steel bolts which pass through large steel bosses welded to the girders. The bolts were tightened to a predetermined tension using a spanner operated by a hydraulic jack. The load imparted was determined by elongation as each bolt was tightened and this was measured by use of a micrometer. The crab rails are fixed to the top flange of the box girders at 20ft centres.



One of the 200-ton hoisting " crabs " preassembled at the maker's works

To withstand lateral forces, such as surge and wind loads, the bridge girders are connected by horizontal bracing between the top and the bottom flanges. The tension links forming the bottom boom of each main girder are " flats " of high-tensile structural steel. These links are connected by large pins to the lower ends of the three vertical struts, the upper ends of which are bolted to the box girder flange. As it was proposed to prestress the main girders on installation, the final lengths of the vertical struts could not be fixed until the prestressing had been carried out. For this reason the struts were first made adjustable for length, and initial prestressing was carried out at the works, using hydraulic jacks to apply calculated working loads to the girders at the struts. When the final length of each strut had been determined with the calculated load applied, the strut was fixed at this length.

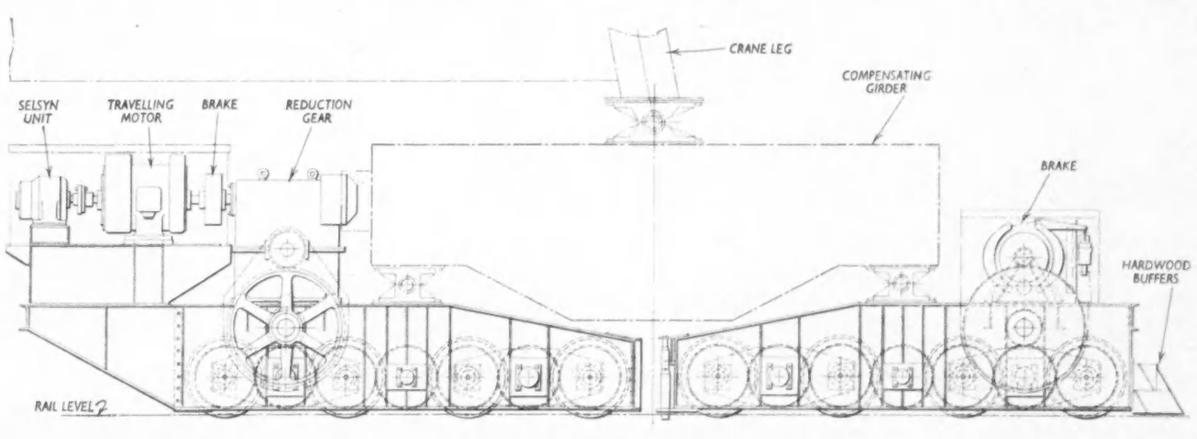
In the crane legs all the members, both vertical and horizontal, are of box-section welded plate construction, the main leg members being made of high-tensile and the other parts of mild steel plate. Accurately machined ends on the sections ensure a good face contact between the connected members, which are joined by large high-tensile steel bolts using a similar tensioning means as with the main girders.

The welded design gives a light and economical structure, and the method adopted for connecting the members with large diameter high-tensile bolts has reduced to a minimum the number of bolts necessary. By this use of box-section main girder and leg members, connected with large bolts and having mating machined ends, the number of bolts used was, in fact, restricted to just over 4000. It is of interest to note that the makers consider that if an orthodox braced structure design had been adopted for the crane the number of bolts required would have been over 50,000. The structure was designed to withstand wind loads of up to 100 miles per hour velocity.

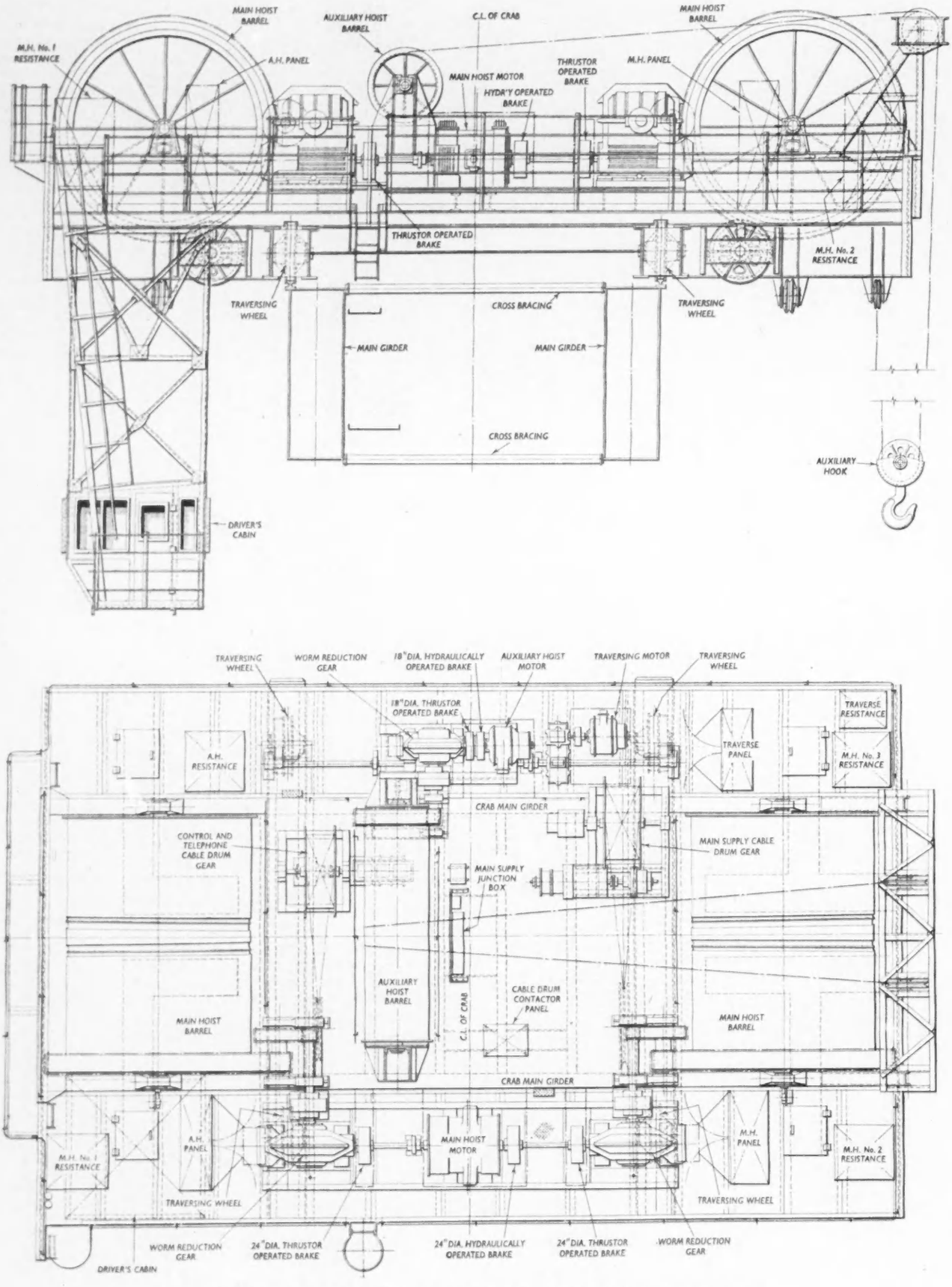
When the main girders, complete with their tension links and struts, were fully erected on trestles in the Dalmuir shops, as shown in one of our illustrations, the top parts of the legs were fitted to the ends of the girders to check for assembly on site. Both of the legs were also completely assembled in the shops, and their feet fitted in the travelling bogies, which were also fully assembled together with their drives and compensating girders. When the crabs were assembled in the shops all their motion gears were run light for checking purposes. Subsequently all the assemblies were dismantled to the extent necessary for shipment.

As already mentioned the maximum working load of 400 tons is handled by two crabs each having a capacity of 200 tons. When loads up to 200 tons are being lifted, one crab only is used, the other being parked at one end of the bridge. One of the crabs assembled at the Dalmuir works is illustrated on this page and the arrangement of the equipment can be seen in the drawings on page 70. Because of the lateral bracing between the main girders of the bridge it was not possible to take the hoisting ropes from the barrels down between the girders. For this reason the hoist barrels on each crab are positioned at the outer ends so that the ropes from one barrel extend down the outside of one main girder, and those from the other barrel down the outside of the other main girder. These ropes are connected to the ends of a lifting beam which has at its centre a 200-ton hook. The main hoisting gear motor on each crab has an output of 150 b.h.p. and drives the two 10ft diameter main barrels through worm and spur gearing. An auxiliary hoisting gear also mounted on each crab is driven by a 45 h.p. motor and is capable of handling a load of 30 tons at 16ft per minute. The ropes from the auxiliary barrel, which is placed near the centre of the crab frame, are led over pulleys so that the hook operates on the outside of the girders, at one side. Each crab is mounted on four rail wheels and is traversed across the girders by a 30 b.h.p. motor driving two of the rail wheels through worm and spur gearing. The crab has a welded frame, the fabricated members of which are bolted together where necessary to permit dismantling for shipment. From each crab there is suspended an operator's cabin which contains the master controllers for all motions.

The two feet on each crane leg are each supported on a compensating girder which is in turn supported on two bogies. As can be seen from one of the illustrations and a drawing we reproduce each bogie has four rail wheels running on a single track, the wheels and bogies being fully compensated. One of the bogies of each leg is equipped with a motor which drives all four of its wheels through worm and spur gearing, the companion bogie in each case having four " trailing " wheels with braking equipment. Each of the four bogie motors is of 80 b.h.p. and they give the crane a travelling speed of 50ft per minute. Directly coupled to each motor is a 35 h.p. Selsyn and these units ensure the synchronisation of the four travelling motors under all loading conditions. The rail tracks on which the crane travels consists of a heavy flat-bottomed single rail attached to a steel bearing-plate which rests on the concrete founda-



Arrangement of travelling drive and bogie



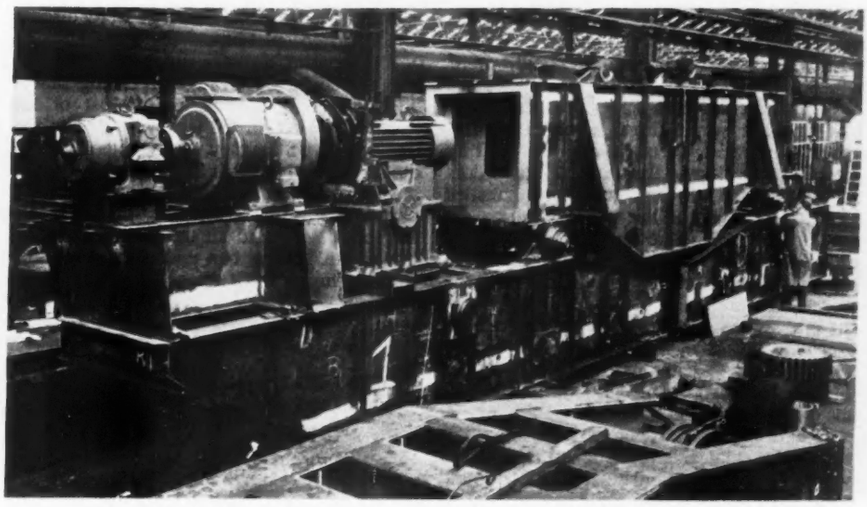
Arrangement of one of the two 200-tons capacity "crabs" of the Goliath crane at Hinkley Point

tions, the length of the track being 1638ft.

The electrical supply to the crane is 415V, three-phase, 50 c/s, and the main supply switch and junction box are situated at the middle of the length of track. From this point current is carried to the crane by twin trailing cables in parallel, the cables being of sufficient length to allow the crane to travel the whole length of the track without changing the point of supply, The trailing cables are wound on to two motor-driven cable drums fixed to horizontal girders at the bottom of one leg. From the cable drum the wiring is carried to the top of the leg in tray conduits fixed to the steelwork.

On the top of each leg there is a junction box from which trailing cables are taken to the crab motors and to the controllers in the operators' cabins, each junction box serving one crab. One of two motor-driven cable drums on each crab is for the cable carrying the main supply current and the other for the cable carrying the control and telephone wiring. In the operators' cabins are the master controllers for the main hoist, auxiliary hoist, and cross-traversing motions for the respective crab. There is also in each cabin a master controller for the travelling motion of the crane, electrical interlocks being provided so that the two drivers cannot operate the motion at the same time. The four travelling motors with their power selsyns are arranged to run together, and are operated from one controller in either cabin, through reversing-contactor control gear, which is suitable for plugging in either direction of travel. The main hoist and auxiliary hoist control gear and the cross-traversing control gear of each crab are of reversing-contactor design operated by a master controller for each motion, with provision for slow-speed hoisting and lowering, and for plugging in both directions of traverse.

An electrically-operated passenger lift on one of the legs gives easy access to the top of the crane, and on the same leg there is a stairway leading to the top. Communication between the crane drivers in their cabins and personnel at ground level is by a "Loudaphone" instrument in each cabin. A head-and-breast set worn by a driver is connected with "Loudaphone" hand-sets and buzzers on the travelling-bogies at the feet of the crane.



One of the four power-driven bogies during erection

Crane bridge being raised into position at top of the legs using the main "crab" hoisting gear

Erection of the Crane

All the parts of the crane were transported by sea from the maker's docks at Dalmuir works to the port of Combwich, Somerset, which had been specially rebuilt and equipped to serve the Hinkley Point site. Transport from Combwich to the site, some 4 miles away, was carried out by British Road Transport vehicles.

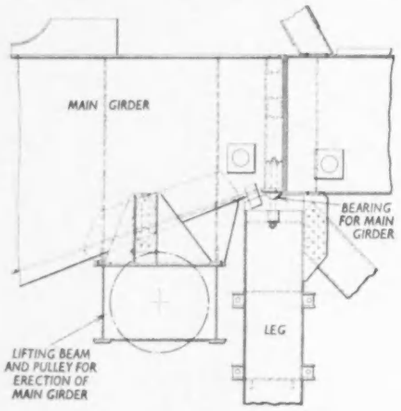
While the design adopted made the erection of the crane as simple as possible, this operation required extremely careful planning and presented considerable problems, the basic requirements being the erection of the legs, in sections, to their full height of 235ft, the weight of each leg being 175 tons, and then the lifting of the main girder assembly, or bridge, complete with its two crabs, and weighing over 640 tons, to the top of the legs. In order to study the erection procedure a working scale model of the crane was made. This model was large enough to indicate clearly every member of the structure so that the erection of each could be considered in the erection programme.

The rail tracks were first laid on the site with considerable precision as regards level and rail centres. The bogies were next erected on the rail tracks complete with their compensating girders which support the legs, struts being fitted to the girders to keep the bogies in the correct position until the legs were erected. For erection purposes the leg members were made in the form of panels and the first panel of each leg was erected by a mobile crane. Successive panels were then raised and fixed, using a gin-pole supported on the horizontal leg-members of the panel, below until assembly of the legs was completed. As the leg-panels were assembled, each structure was held by guy ropes secured

to prepared anchor-blocks and when the first leg-panels had been secured the temporary struts used to position the bogies were removed.

Whilst erection of the legs proceeded, the main girders were being assembled on the ground between them, ready for lifting directly to the top of the crane. The girders were supported on the same special trestles used for assembly at the maker's works, the trestles being bolted to concrete foundations on the site. The box girders were assembled on the trestles exactly as they had been at the works. Before the girders were prestressed, the crabs were assembled on the bridge, one at each end, it having been arranged previously that the jacks used would be strong enough to prestress the girders at site with the crabs in position.

It had been decided in the early stages of the design that the bridge, with the crabs, would be raised complete from the ground to its final position, using the legs as erecting towers. The main hoist gears on each crab were used to hoist the bridge into position. For this purpose, the ropes from the main hoist barrels were led to pulleys located in lifting beams fixed to the ends of the girders,



Connection of bridge girder to crane leg

and thence over pulleys in structures fixed to the tops of the legs. Before the crabs were used as hoisting winches they were tested by applying a load 25 per cent above that which the gear would take during erection of the bridge. As the legs were to be used as erecting towers, they also were first tested by adding ballast weights to the ends of the bridge, which, complete with the crabs, was lifted a few feet and then lowered back on to the trestles. The ballast weights were then removed and the bridge with crabs was ready for hoisting. One of our illustrations shows the bridge being raised.

The legs were initially erected inclined outwards a few feet at the top from their final position, in order that the bridge would clear the legs while being lifted. The bridge was first hoisted a few inches above the top of the legs which were then drawn in under the ends of the bridge girders by rods. These rods were attached at one end to crossheads on the girders and at the other to crossheads and hydraulic jacks fixed to the legs. As the jacks were operated to bring the inwards legs at the top, the outer guy ropes were correspondingly adjusted. When half-round shafts fixed to the ends of the bridge girders were ultimately located in the half-round bearings provided at the tops of the legs, as shown in the drawing above, the ends of the girders were bolted in position. The corner diagonal struts connecting the main girders to the legs were then put in position and bolted up, using friction-grip bolts.

When the guys on the legs were disconnected on completion of the main erection of the structure, the hoist ropes were re-reeved and the crane was ready for testing before being put into commission. Most of the electrical wiring on the legs was fixed to the leg sections before they were erected and was quickly completed when the legs had been fully assembled. The crabs also were completely wired during assembly on the bridge at ground level and all the wiring along the bridge girders was run and fixed while they were resting on the trestles.

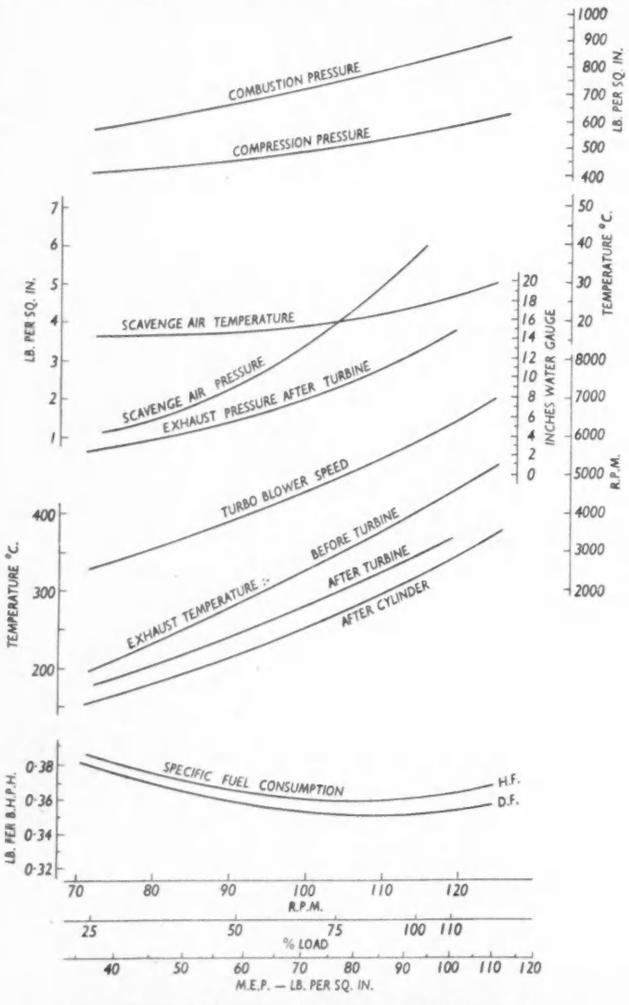
When the crane was ready for testing, all the motions were run light before a load of 200 tons was suspended from the hooks and tests were then carried out on all motions. The maximum working load of 400 tons was then raised and the crane again tested in all motions, the deflection of the main girders being recorded. When the tests with the maximum working load had been completed satisfactorily, a final test load of 500 tons was applied. The crane on the completion of a final overall examination at the conclusion of these tests was issued with its test certificate.

A Twelve-Cylinder Diesel Engine

A twelve-cylinder Sulzer Mark R.S.A.D.76 diesel engine recently completed shop trials at the works of Alexander Stephen and Sons, Ltd., and the engine, which forms the main propulsion unit for the Ellerman cargo liner "City of Melbourne," has a very conservative service rating of 14,000 *b.h.p. in service.*

TOWARDS the end of last year Alexander Stephen and Sons, Ltd., completed its first turbo-charged Sulzer engine which was a seven-cylinder unit for the 15,500 tons deadweight tanker "British Fulmar." The company has recently completed a Mark R.S.A.D.76 twelve-cylinder turbo-charged engine, of 760mm bore by 1550mm stroke and rated at 15,400 b.h.p., which will form the propulsion unit of the Ellerman Line ship "City of Melbourne" recently launched from the yard of the engine builders.

This single-acting, reversible, two-stroke, direct injection, turbo-charged engine, of which we reproduce a sectional elevation, has its cylinders at 1400mm centres, except numbers 6 and 7 which are spaced at 2250mm, to give the engine an overall length of 21,090mm, while the height above the crankshaft is 7825mm. Including water and oil the engine weighs about 723 tons. The welded bed plate, of box construction and forming part of the oil sump, is in four sections bolted together, and the columns are fabricated from mild steel plate while long pretensioned tie rods extending from the bed plate to the cylinder tops relieve main weld runs of tension stresses. Close grained cast iron is used for the individual cylinder jackets, which are bolted together and held in compression. Cast iron containing a vanadium-titanium mixture is used for the cylinder liners, which are not honed but have a turned finish and are double walled in way of the exhaust ports for cooling purposes. Heat resistant rubber rings seal the liner from the cooling water chamber. The cylinder head is in two parts, the outer part being of cast steel and the insert being of special cast iron and having four bores to take fuel, starting air, relief and indicator valves. The fuel valve is of needle pattern, designed to operate with heavy fuel, and water cooled from its own circulating pump, and the relief valve blows off at about 75 atmospheres.



Average principal readings taken during official shop test

There are three parts in the piston assembly, an oil-cooled crown of forged steel fitted with piston rings, the grooves for which are not specially treated, a banded cast iron skirt and a piston rod bored to take the feed and return pipes of the cooling oil system. Both top and bottom end bearings of the forged open-hearth steel connecting rods are of steel lined with white metal, and steel shell white metal lined bearings carry the semi-built crankshaft which is in three parts, two lengths for the working cylinders, and an extension for the built-on thrust block. Double cast iron guide faces take the crosshead shoes, which have white metal sliding surfaces. Cooling oil for the piston is supplied through a swing linkage to the crosshead, while the guide bar is cooled by oil from the main bearing lubrication system and only the ahead guides are cooled. Lubrication of the main journals, although off the same supply, is delivered at a lower pressure through a reducing valve.

Oil scrapers fitted in the piston rod stuffing boxes serve as sealing rings and are in two groups ; the upper group removes residue from the piston rod and the lower group removes oil splashed on the piston rod in the crankcase.

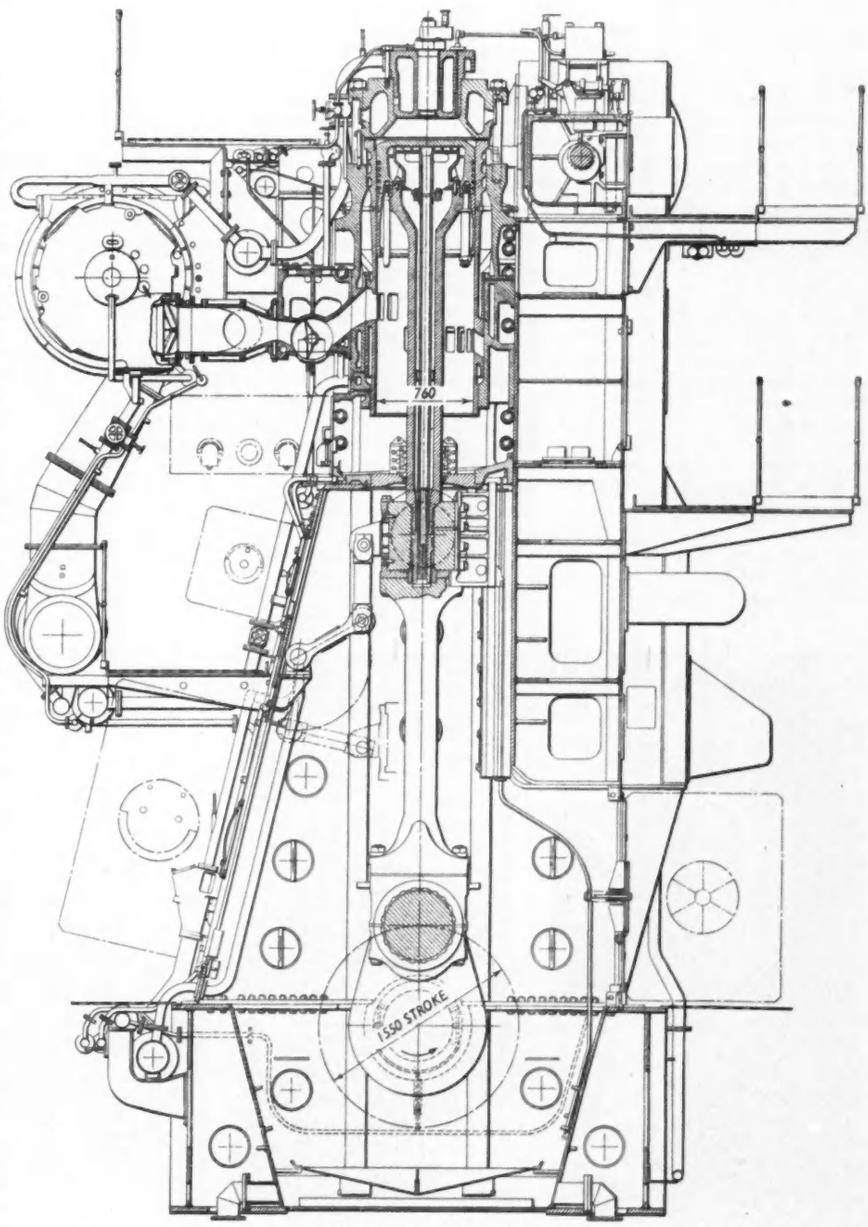
The scavenge air manifold is fabricated and bolted to the columns and is common to all cylinders. Scavenge air is supplied by four Sulzer turbo-blowers and the air passes through coolers, arranged one at each end of the engine, before entering the receiver, from which it passes through non-return valves to the under piston spaces associated with individual cylinders. Control of the air is by the top edge of the piston and in order to retain air for combustion when both the inlet and exhaust ports are uncovered there is a semi-rotary exhaust valve in the exhaust pipes which is closed until the exhaust ports are covered by the piston. This valve also prevents the scavenge air from passing straight through to the blowers when the piston is near top dead centre. An eccentric on the camshaft actuates the valve through mechanical linkages which are spring loaded so that the linkages will continue to operate should the valve stick. The undersides of the pistons act as scavenge pumps so that the downward stroke of the piston raises the pressure of the scavenge air above that as delivered from the blowers.

Each turbo-blower has a turbine wheel and an impeller on one shaft and is connected by short insulated pipes to the exhaust ports of three cylinders. The blowers have a maximum speed of 7800 r.p.m. but the working speed is about 4500 r.p.m. and the air pressure approximately 5 lb per square inch. Temperature of the exhaust before the blower is 750 deg. Fah. and the temperature of the air after the blower and before entering the Serck coolers is about 135 deg. Fah.

Lubrication of the blower bearings is from the engine piston cooling system and is passed through special filters. After passing through the blower turbine the exhaust gas is piped to a waste heat boiler which is rated to raise 4200 lb of steam per hour at 100 deg. Fah. when the main engine is developing normal service power. Even should all the blowers be out of action the engine will be able to run at about 75 per cent of speed.

Individual fuel pumps, of Sulzer design and manufactured by Wilson and Kyle, Ltd., are provided for each cylinder and are mounted in pairs over the camshaft. Each pump is actuated by a cam and roller, and fuel is delivered to the pump at a pressure of 25 lb per square inch by a transfer pump and delivered at high pressure by the fuel pump in timed and metered quantities to the cylinder via injectors. Fuel up to 3500 seconds Redwood can be burnt and for this purpose the fuel pump blocks are steam heated and all the pipes are steam traced. The quantity of fuel injected is controlled by regulating linkages, connected to a variable speed governor, which act upon the fuel pump suction and spill valves. The relative openings of suction and spill valves can also be adjusted so that the ignition can be advanced or retarded with the engine running. When reversing, the camshaft is moved by servo-motor 60 deg. towards the new direction of rotation and the same fuel cam is used for both ahead and astern running. A Woodward hydraulic governor is fitted and this is set to prevent the engine speed rising about 5 per cent above that for which the controls are set.

A Bosch lubrication system is fitted and the engine is started with compressed air, at 440 lb per square inch. The starting lever operates an automatic valve which supplies air to the starting valve at each cylinder while at the same time air is supplied to the pilot starting valves. The latter are operated by a small camshaft and deliver air to the appropriate main starting valve and either open or close it as the position of the engine requires. Engine controls are placed at the forward end of the engine, together with the instrument panel, and are interlocked with the telegraph and turning gear to prevent wrong manœuvres or the engine being started with the turning gear in. A " Holset " damper reduces torsional vibration stresses to a safe level, while the engine will be stopped automatically should there be a failure of the supply of lubricating oil, cooling oil or cooling water. The engine develops its service power of 14,000 b.h.p. at 114·5 r.p.m. and a brake mean effective pressure of 94·3 lb per square inch, and during shop trials the engine developed 18,000 b.h.p. at 125 r.p.m., the brake mean effective pressure being 110 lb per square inch. The principal readings taken during the official shop test are given in the graph.



Vertical cross section through twelve-cylinder diesel engine

Underground Mining Machinery

The latest products of nearly a hundred British manufacturers of mining machinery were shown at an exhibition in London in July last. In this article we give particulars of some of the underground plant which has not previously been dealt with in our columns.

DURING the past ten years a considerable amount of the development work which has been carried out by underground mining machinery manufacturers in this country has been in connection with the extensive modernisation programme for British coal mines, and up till recently practically the whole output of the firms making mining plant was devoted to meeting the requirements of the National Coal Board. A decrease in this demand over the past year or so and an increasing productive capacity have now enabled British manufacturers to turn their attention to overseas markets. In this connection the exhibition organised by the Council of Underground Machinery Manufacturers and held at Olympia in July provided buyers from abroad with an opportunity to inspect British equipment, a majority of which is of advanced design and well adapted to conditions in mines in other countries. Over 24,000 visitors attended the exhibition and of those 10 per cent came from overseas countries. We were unable to deal with the exhibition whilst it was in progress, but have now selected for purposes of record some of the representative equipment indicative of the developments which have been made in mechanisation designed to increase the output and safety in working in mines.

Probably amongst the most spectacular machines exhibited were power loaders, of which no fewer than 1018 in service in British mines in 1958 accounted for the production of some 65,620,000 tons of coal. Of this output Anderton shearer loaders were responsible for over 40 per cent. The latest model of this machine made by British Jeffrey Diamond, Ltd., of Wakefield, is designed to ride on a 30in wide armoured conveyor which gives the necessary handling capacity. It is driven by a 125 h.p. continuously-rated, water-cooled motor and is stated to have a potential cutting rate of 30ft per minute according to seam hardness.

The demand for large coals in this country has led to the introduction of a number of adaptations and attachments for longwall coal cutters. One such attachment known as the "Mawco" has been developed by Austin Hoy and Co., Ltd., Saunderton, High Wycombe, for fitting on longwall coal cutters, particularly disc shearers, to adapt them at a reasonable cost for the production of large coals. This cutter loader is shown in an accompanying illustration and for it the horizontal drive shaft of the disc shearing unit is shortened and fitted with a chain driving sprocket. If so required by the cutting conditions a breaker bar can also be fitted on the shaft as shown. The attachment has a side-flexing "Hoy" cutter chain, driven from the sprocket. This chain is carried on a frame jib shaped to cut out a segment of the coal face at the roof, back and floor. The kervings and the segment of the seam which passes through the frame are collected in the tray of a plough and deflected up an inclined and curved ramp on to the conveyor system. A limited degree of height adjustment can be provided on the machine and the upper section of the frame jib can be lowered for flitting purposes.

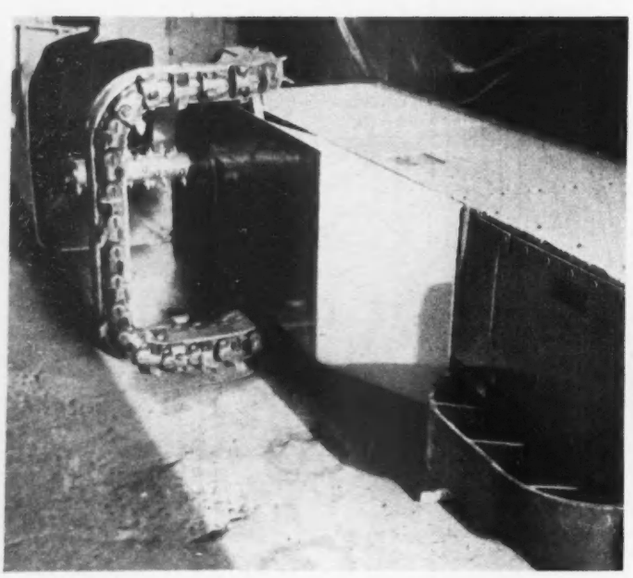
When fitting the attachment to a standard longwall cutter the modifications required are confined to one side of the gear head and the drive gears changed to give the required chain speed. It is stated by the makers that in extended trials on a machine with the attachment cutting speeds of about 6ft to 9ft per minute were maintained. The plough fitted with the attachment is a self-contained unit and is fitted with a hinged panel which can be swung around during flitting to clear any coal left on the floor after a cutting pass. A toothed roof trimmer is mounted above the plough.

Another Anderton shearer conversion unit which is designed to produce as cheaply as possible a reasonable percentage of large coal is the "Coal Winner" of N. J. Muschamp and Co., Ltd., Station Street, Mansfield. This unit, illustrated below, is built to cut at both the top and the bottom of a seam with rotating drums of comparatively small diameter and simultaneously shear the back of the cut with a narrow-kerf jib and chain. The production of fines is thus confined to the actual cutting areas and the main section of the seam is extracted untouched by the cutter picks. The coal is delivered at the rear of the machine on to a loading plough and thence on to the armoured scraper chain conveyor on which the complete machine is mounted and traverses the face.

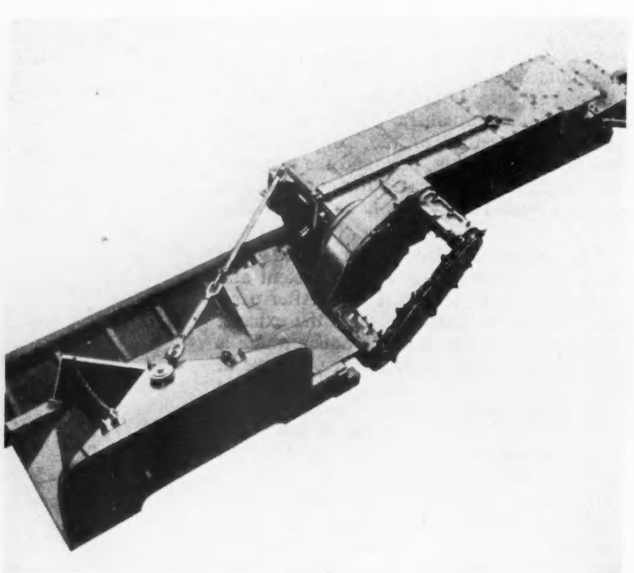
The standard cutting head bolted to the machine is pivotally mounted in the position normally occupied by the shearer drum and by rotation about its central pivot it can be arranged to cut many different heights of seam without alteration to the head itself. The only adjustment required is the raising or lowering of the machine on top of the conveyor so that the lower cutting drum is always operating at floor level. The cutting head consists of a gearbox bolted on to the machine and having at each end, projecting at right angles, a rotatable drum carrying cutter picks. These drums are connected at the face side by a shearing jib and chain of conventional design.

The loading unit attached to the rear of the machine comprises a hydraulically-driven chain-and-flight gummer, operating at floor level and discharging on to the conveyor. It has a wedging platform designed to break down extra large pieces of coal to manageable proportions, and a plough for diverting the coal on to the conveyor. The plough section has leading and trailing faces and a hinged central partition so that it will operate in either direction of travel. When flitting this plough automatically clears the face in preparation for the next cut.

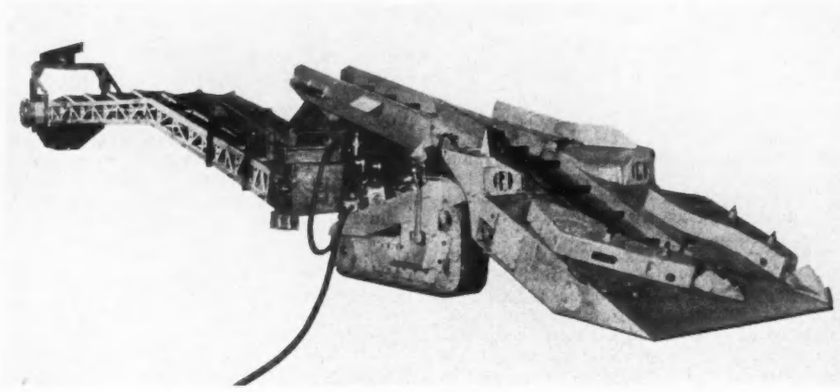
Two outstanding machines developed in recent years by Joy-Sullivan, Ltd., Cappilow, Greenock, Scotland, were the double-ended longwall buttock miner and the "Continuous Miner" described in our issues of August 8, 1958 and February 22, 1957 respectively. A "Continuous Miner" fitted with a 7ft ripper bar shown at the exhibition was linked by a bridge conveyor to an extensible belt storage conveyor with a crawler-mounted mobile tail-end unit. This



"Mawco" attachment for longwall coal cutters



"Coal Winner" conversion unit for Anderton shearing machine



"Samson" loader carrying bridge conveyor

machine with its 7ft ripper bar cuts up to 118in and is stated to have a cutting capacity up to 4 tons a minute. It is self-propelled on crawler tracks and the ripping head, with a horizontal and a vertical movement, discharges the cut coal on to an intermediate conveyor feeding into a central hopper.

The bridge conveyor was developed as a connecting link to gain the flexibility needed to keep the extensible belt storage conveyor in a straight line, yet permit the "Continuous Miner" to drive cross cuts during an advance. The bridge conveyor is suspended at one end from the tail boom of the "Continuous Miner" and supported at the discharge end by the tail section of the extensible belt; it enables coal to be taken continuously from the machine to the belt, irrespective of their relative positions. The extensible storage belt conveyor is designed to keep up with the machine's rapid rate of advance by paying out conveyor belting. Reels of 100ft of belting stored in the machine each allow the conveyor to extend up to 50ft and successive reels can be joined for the extension to be continued up to 1000ft if desired.

For the extensible belt system there are mounted in a storage box immediately ahead of the drive head of the conveyors, six belt pulleys over which the belt for extension is carried. Three of the pulleys are on fixed shafts at the drive end of the box, while the other three are mounted on a movable carriage running on rails inside the box for its full length. A hydraulic ram can be extended 40in to haul forward the travelling carriage and pulley cluster a distance of 17ft which is sufficient to provide a store of up to 100ft of 24in or 30in width belting.

The radial percussive coal cutters made by Siskol Machines, Ltd., of Sheffield, which are intended for use in narrow places and development work, can now be supplied with an integral hydraulically-operated traverse mechanism. The machine is powered by a 5 h.p. flameproof motor and in operation its five-pronged cutting tool strikes the coal face with a combined percussive and rotary action at some 400 blows a minute. At the same time the tool is swung by hydraulic power in an arc across the coal face. Pressure fluid for the hydraulic system is supplied by a small pump at the rear of the motor and is delivered to a rotary actuator mounted on the vertical column of the machine. This column also serves as a jack between the floor and the roof to hold the machine in position during cutting.

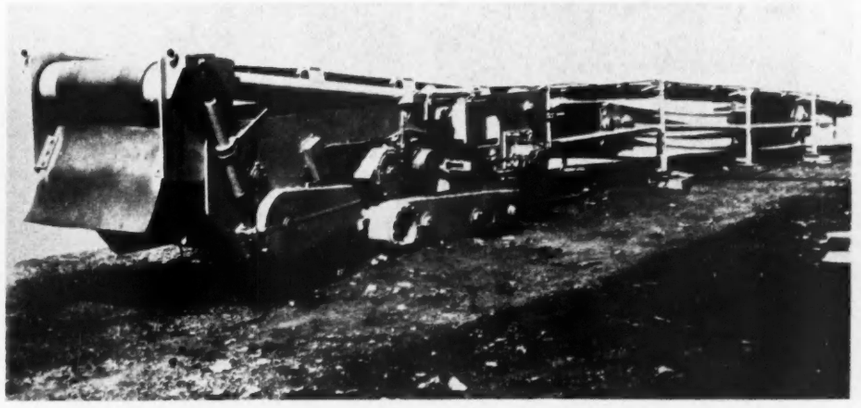
A flexible drive rotary drill can be used in conjunction with the new machine and for it the hydraulic pump is removed for the drive to be coupled to the power take-off at the rear of the main motor. With this attachment the machine can be quickly converted from a cutter for drilling without delay and whilst in position. The drill is driven at 500 r.p.m. through gearing from the power take-off and has a normal capacity for drilling holes up to 2½in diameter.

An equipment designed to enable rapid removal of material from a tunnel face or heading is the "Samson" loader connected by a bridge conveyor to a gate conveyor made by Mavor and Coulson, Ltd., Glasgow, and illustrated on this page. The bridge conveyor provides a means of taking away what is gathered by the loader and delivering it continuously to a conveyor on the floor. The loader has the usual short jib which can be raised or lowered hydraulically and, underneath, it has an arm by which it can raise one end of the bridge conveyor and carry it clear of the ground. The bridge conveyor has a lattice steel framework supporting a troughed belt conveyor driven from a 5 h.p. hydraulic motor at the head pulley. The hydraulic supply pipes run to the tail end of the bridge where there is a connection to a pump driven by the loader motor. When installed underground the outbye end of the bridge conveyor is either hung by a pivot from a wheeled block running along an overhead girder, or supported on a carriage astride the gate conveyor. At both ends of the bridge plates guide the material, and the joint fitted allows a relative movement of up to 90 deg. to each side.

Much development work has gone into means for the efficient and rapid removal of coal from the face to keep pace with the high rate of production by mechanised cutting equipment, and a significant power increase has taken place in conveyor drive units to permit the use of larger, longer and higher speed belts. In this connection interest attaches to the ropebelt conveyor which was developed in the United States about five years ago and is now being made by the Distington Engineering Company, Ltd., a subsidiary of the United Steel Companies, Ltd. In this conveyor the conventional rigid form of belt supporting structure is replaced by wire ropes suspended along each side of the belt. The belt ropes have slung at intervals between them troughing idler rollers on which the upper run of the belt is supported, the return side of the belt being carried on rollers set between the legs of the welded tubular supporting stands for the ropes. The idlers clamped between the ropes can be spaced to suit the degree of belt loading, and their troughing effect combined with the flexible method of suspension reduces spillage to a minimum. The welded tubular support stands have legs which are adjustable for height to provide for irregularities in the floor level. Each troughing idler assembly consists of a base and two side rollers mounted on sealed roller bearings and having their shaft ends connected by pivoted links to permit a free universal movement. Usually the wire support stands are spaced at 20ft intervals along a conveyor and a spreader is mounted between the wires midway between the stands.

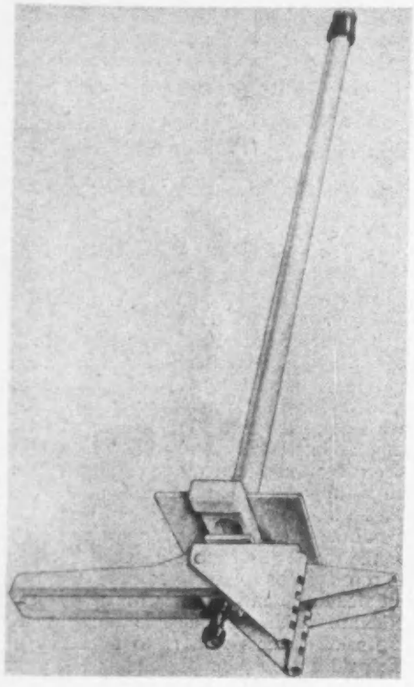
Another new product of the firm is the Distington-Goodman "Ropex" extensible belt conveyor, which is to be seen in an illustration on this page and is designed to be operated in conjunction with a loader or a continuous mining machine, With this equipment the conveying belt, whilst still operating, is extended as the tail end is moved forwards as the loading machine advances into a working face. To allow this extension a length of belt sufficient to permit an extension of 50ft or 100ft is stored between carriage mounted rollers in a take-up frame in the head end assembly. At the head end a 35 h.p. motor drives the conveyor belt at 400ft per minute through tandem pulleys and the assembly is mounted on a crawler tractor by which it can be traversed at 40ft per minute. As the tail is moved an additional length of belt is let out by movement of the take-up assembly spools and a hydraulic winch in the take-up gear automatically maintains the belt tension constant. The height of the discharge pulley is adjustable from the minimum of 42in up to a level of 78in by operation of a pair of hydraulic jacks.

The tail end is carried on a self-propelled crawler tractor giving a tramming speed of 40ft per minute and it can be equipped for shuttle car loading or linked by a bridge to a loader or continuous mining machine. The head and tail ends of the machine are



Distington-Goodman "Ropex," conveyor, showing head section with intermediate structure

connected by an intermediate section in which the belt is supported on wire rope-slung troughed idlers in a similar manner to the rope belt conveyor. Additional lengths of conveyor belting can be quickly introduced into the take-up frame when the limit of extension has been reached and to facilitate this operation a belt spooling device can be installed. These conveyors



Recoverable strata bolt with holding bush under compression

are suitable for operating lengths up to 1000ft on the level.

Amongst the equipment of interest to overseas mining engineers are the "Canopy" and the "Rodjo Shield" developed by Dowty Mining Equipment, Ltd., Ashchurch, Glos, for roof safety in mechanised short-wall mining. These self-advancing roof support equipments are a development of the "Roofmaster" support units used for longwall mining, one of which was described in our issue of June 20, 1957. They provide protection from roof falls over a mining machine in the freshly exposed area near the face of a heading.

Above we illustrate a new strata bolt made by Dowty Mining Equipment, Ltd., which in tests has shown a holding power varying from 3 tons in soft clod to 10 tons in hard sandstone. The grip of these bolts, which are designed for use in standard holes, is provided by expanding a synthetic rubber bush at the top end of the tube. This is done by drawing downwards a plate above the bush through tightening a nut at the foot of a bolt extending down through the tube. A patch plate at the bottom of the tube is then driven hard against the rock face by hammering in a wedge to prestress the bolt. A bracket, also welded to the tube, carries a timber support which can be adjusted in height.

When it is required to remove the bolt the handle to be seen extending to the left in our illustration is pulled downwards by a chain or rope from a safe distance. The pivoting of this handle releases the load on the bolt so that the rubber bush is decompressed for easy withdrawal of the assembly by continued pulling on the release chain.

26·MW Silicon Rectifier

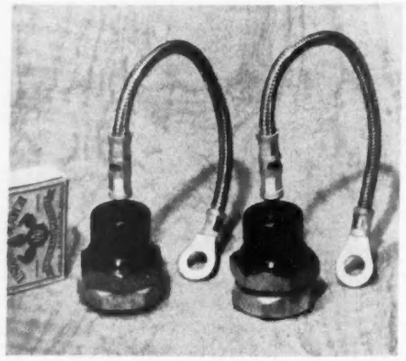
WE illustrate one of the four rectifier cubicles that will make up a 2·6MW silicon rectifier for the electrolytic production of manganese at the Electrolytic Metals Corporation works in the Transvaal, South Africa. The rectifier is being made by Standard Telephones and Cables, Ltd., at Harlow, Essex.

The four rectifier cubicles are paralleled on the d.c. output side to supply the complete power requirement for the electrolytic process. A 3150kVA regulator controls the whole equipment consisting of four transformer-rectifier sections, each of which is equipped with its own a.c. and d.c. isolators, so that any one section can be under maintenance while the remainder operate the plant at 75 per cent full load.

To hold the total output current within 2 per cent of any desired value between 15,000 and 20,000A there is a constant-current-control loop operating the 3150kVA regulator in response to a transductor connected in the positive d.c. busbar. The current setting is made by the plant operator at the control panel in the electrolytic plant area. The regulator can also be used to control the output down to 65V at no load.

Because the equipment is not paralleled with other conversion apparatus liable to give overload conditions there is no need for d.c. circuit-breaker protection. Fault current limitation is provided by the regulator and supply line reactance, in conjunction with the built-in reactances of the rectifier transformers. Normal d·c. overloads are unlikely from the electrolytic process, but protection against such faults is arranged by a.c. circuit-breaker tripping from current transformers in the a.c. isolator panel.

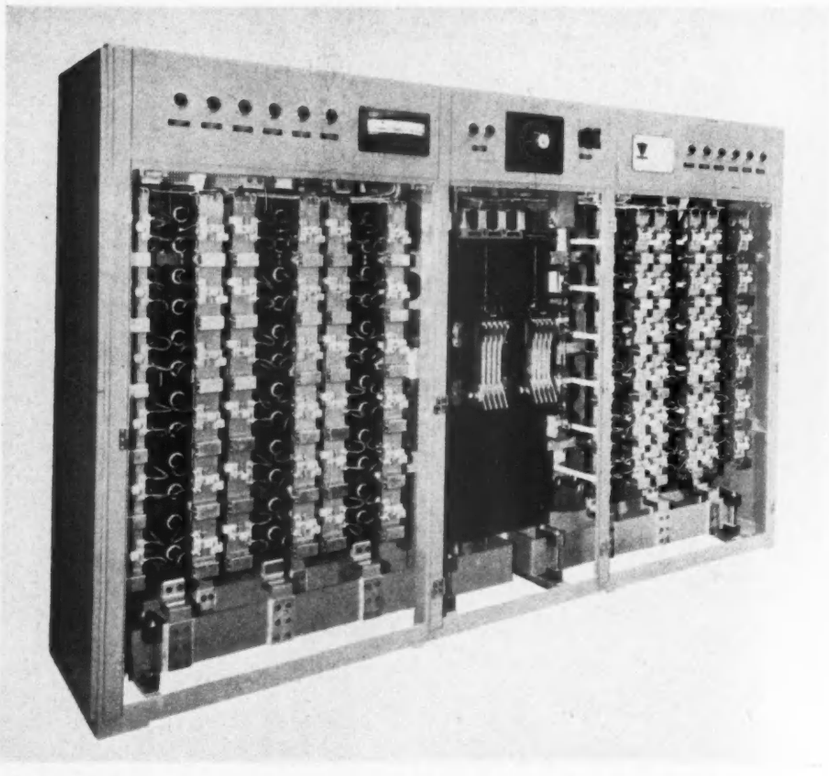
Each of the four rectifier cubicles illustrated contains 144 "RS8" 100A silicon rectifiers (illustrated) connected in two three-phase bridge circuits, supplied from common a.c. busbars and feeding through separate isolators into the main 20,000A busbars. Six hollow aluminium busbars form the arms of each three-phase bridge and provide cooling, by oil circulation, to the twelve paralleled rectifiers in each busbar. Each arm of a bridge thus contains twenty-four parallel operated silicon rectifiers. English Electric high-speed fuses protect each pair of rectifiers. Failure of one fuse in any arm is shown by an indicator lamp; failure of more than one fuse in any one arm initiates a warning system.



Silicon rectifier with continuous rating of 100A, surge rating of 1000A, designed to operate at 300V peak inverse voltage with a case temperature of 100 deg. Cent.

A thermocouple near the top of each hollow busbar is connected to a Cambridge multi-point temperature indicator.

Cooling oil is circulated upwards through the hollow busbars by a duplicated oil pump and passes through an oil-to-water heat exchanger. The water is in turn circulated through a cooling spray pond. The overall operation of the cooling system maintains the oil temperature below



One of the four silicon rectifier cubicles for the Electrolytic Metals Corporation, Transvaal. Each cubicle contains 144 "RS8" rectifiers mounted on twelve oil-cooled busbars connected in two three-phase bridge circuits

46 deg. Cent. when 6000 gallons of oil per hour are cooled by 6500 gallons per hour of water at 30 deg. Cent. Failure of the oil or water coolants disconnects the load.

The calculated full load efficiencies are 94·6 per cent overall and 98·2 per cent for the rectifiers alone. Auxiliary plant losses are minimised by the use of grain-oriented sheet for the transformer cores.

The four rectifier cubicles (each with its transformer behind it) will be installed in line in a room measuring 50ft by 20ft. In the centre, between the second and third cubicles will be the main control panel and behind it the cooling oil pump and the oil/water heat exchanger. Only the a.c. circuit-breaker and regulator are installed outside this room.

A wall will separate the rectifier room from the electrolytic cell area, but a small control panel will project through this wall into the cell area. The positive and negative 20,000A, 130V busbars are taken into the cell area through this wall from the opposite ends of the rectifier line.

British Welding Research Association

IN his speech welcoming the guests and members to the open day of the British Welding Research Association research station at Abington Hall, Cambridge, on July 14, Sir Alexander Fleck spoke of the many branches of industry served by the association. He said that the wide field served was both a strength and a weakness. A strength in that the association could cast a wide net for the financial resources and also because the important advances that it made could find wide applications. At the same time there was a weakness because such diffuse contact with industry in general was not conducive to the development of any kind of corporate spirit. In other words, only the manufacturers of welding equipment could speak of the B.W.R.A. as "our research association." The users, who formed the bulk of the membership, were not on the other hand an easily definable group, covering as they do about twenty different industries, so with them the sense of belonging to the association could not be so highly developed. As a result of this, it was doubtful whether the association received as much support from some quarters as it should. According to the latest annual report some 440 members contributed between them about £75,000 to the income of the association. This sum and membership should be vastly greater, said Sir Alexander, if a reasonable percentage of the firms who could benefit from the work of the association joined in supporting it.

Sir Alexander then turned to the application of the results of research and said that the action of the D.S.I.R. in devoting additional funds to technical liaison and advisory services should be welcomed. In this connection the B.W.R.A. proposed to intensify its efforts in advising members on good welding design and appropriate techniques, and he hoped that this work would be appreciated by those who would benefit from it.

DISPLAYS OF WORK

As upon previous occasions the staff of the station arranged a large number of interesting displays to show the work in hand and the results of a number of projects which have been completed. Gas shielded welding using CO_2 has received much attention and amongst the work carried out in this connection has been the mechanised welding of sheet metal below 14 gauge by the bare wire CO_2 process. A systematic investigation of the relationship between electrical and welding variables and weld bead shape has solved the problems of unfavourable transfer of metal, spatter and irregular bead appearance in this particular application. Using the process welds have been made in a variety of thin sheet materials including low alloy and stainless steels and Nimonic alloys.

The station is often called upon to solve the problems involved in welding dissimilar metals and one of the interesting exhibits on the open day was a flat ring made up of twelve segments of different metals with fusion welded joints. The ring included joints between mild steel, aluminium, copper, stainless steel, aluminium bronze, and nickel.

An investigation which has been in progress for some time is in connection with the improvement of design methods with a view to the rationalisation of code rules for pressure vessels and piping systems. Already the work carried out has shown that there is a substantial reserve of strength in steel plate which could be exploited in more economical vessel design, without increasing the risk of failure. The stresses in the steel tending to produce fracture have been measured with precision at such vulnerable points as the entries of branch pipes. Vessels have been subjected many thousands of times to pressures much greater than those currently permitted, to discover to what extent the fatigue of metal is a danger to safe working. Extensive testing of various welded reinforcements for branch pipe entries has taught much about the relative merits of rival designs and it is hoped that the accumulating mass of evidence from such tests will permit relaxation in present design codes, which are considered excessively restrictive.

DESIGN STUDIES

Particular aspects studied and reported in the past year in this connection have been branch pipes in thick-walled vessels, and charging nozzles for reactor pressure vessels. Stresses were measured on a full size steel drum 40in bore and 5in thick, by wire resistance strain gauges. When pressure was applied, the strains in and around the branch pipes were recorded, and the stress concentration due to the discontinuous shape was deduced. The openings provided in the drum for the pipes were not reinforced by the addition of extra steel in the form of a collar, as is at present the practice, yet even so it was found that the magnitude of the stress was not dangerously high, in fact no higher than exists in many vessels currently in service.

Some interesting work which will probably have a wide field of application has been started on the effects of artificially induced residual stresses in welded assemblies. Certain kinds of welded detail containing discontinuous longitudinal welds are known to have low fatigue strength. Where these welds are used in structures subjected to repeated loading, design stresses must be reduced to guard against failure. Unfortunately, it is often difficult to avoid using them in, for example, the attachment of girder stiffeners and gussets and in the fabrication of beam inter-section joints. The research programme in this connection has as its primary object the improvement of the fatigue strength of such details. The extent to which this is achieved will determine whether allowable stresses can be increased, a development which would have important repercussions in the design of numerous welded structures.

The possibility that a significant improvement might be obtainable by practicable means was indicated by some recent work in Czechoslovakia, which suggested that compressive residual stresses induced artificially at the expected points of failure could produce a large increase in fatigue strength. The method of inducing such stresses made use of local heating with an oxy-acetylene torch and the same method has been applied by the association in studying the fatigue behaviour of three types of mild steel specimen. The results obtained have fully confirmed the Czechoslovakian data, the fatigue strength at 2,000,000 cycles being increased by more than 100 per cent, and similar increase has been obtained with welded light alloy specimens. Another method of inducing residual stresses, by local compression of the specimen between dies has been developed and has given similar encouraging results. Two reports on this exploratory work have been issued.

Amongst the many investigations now in progress in the laboratories is one which has recently been started on ultrasonic welding of thin sheets on to thick plate using frequencies of the order of 20,000–50,000 c/s. The amplitudes used are necessarily much smaller than in sonic welding. Welds may be formed at very low values of normal pressure and the frictional heating effect becomes small and localised at the area of the weld, deformation being negligible.

In connection with the consumable electrode welding of copper it has been found that speed and economy can result from using a mixture of shielding gases—argon with 20 to 30 per cent of nitrogen. The advantages of each of the gases are combined in that the smooth metal transfer properties of argon are coupled with the penetration effects of nitrogen shielding, so that greater penetration is secured and thicker sections can be welded without need for pre-heating.

Atomic Energy Health and Safety Organisation

A REVISED form of health and safety organisation has been introduced by the United Kingdom Atomic Energy Authority. The principle that all Authority staff are responsible via the normal management chain of command for the safety of operations under their control remains unchanged and heads of establishments will continue to receive advice from their own specialist health and safety organisations. Separate health and safety organisations in each Group Headquarters are, however, being eliminated and a new Health and Safety Branch is being established as part of the Headquarters organisation of the Authority. Dr. A. S. McLean has been appointed to head the new Branch with the title of Director of Health and Safety.

It will be recalled that the concept of an Authority Safety Branch was endorsed by the Fleck Committee which reported in January, 1958, on the organisation for the control of health and safety in the Authority (Cmd. 342). At that time the central function was limited to responsibility for problems of reactor safety and was undertaken by the Industrial Group Health and Safety Branch which also had local responsibilities. This form of organisation was dictated by the acute shortage of staff to which reference was made by the Fleck Committee and which imposed a dual role on the majority of key staff: first, to advise on the control of day to day operations at the Authority's establishments; and, secondly, to contribute to the formulation of policy both inside and outside the Authority.

Since the Fleck Committee reported, redeployment of staff and a vigorous recruitment campaign have now made possible the introduction of the revised form of organisation designed to secure a greater concentration of effort. The new Authority Health and Safety Branch will collaborate with, and have the assistance of, the Health and Safety staffs in the Authority's establishments and will have three main functions: first, to advise the Authority on the formulation of their health and safety policy and to disseminate this policy for application by Heads of Groups and Establishments; secondly, to apply this policy to the assessment and inspection of reactors and plants (including laboratories); and thirdly, to provide the focal point from which the Authority's external relations (both technical and political) in the health and safety field will be conducted.

Under Dr. McLean's direction, the technical work of the new Branch will be undertaken by two Divisions as follows:

1. A safeguards division, headed by Mr. F. R. Farmer, at Risley. This division will be concerned with the safety of reactors, plant and laboratories.

2. A radiological protection division, headed by Dr. W. G. Marley, O.B.E., at Harwell. This division will be concerned with all aspects of the health and safety of Authority employees and neighbouring populations, and will advise the safeguards division on the standards of human protection to be applied in the evaluation of the safety of nuclear installations.

Associated with these technical divisions will be an administrative division headed by Mr. I. G. K. Williams.

SHORTER REPORTS

Production Mass Spectrometer

THE first production model of the "MS7" mass spectrometer has been completed by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17, and is illustrated here.

The "MS7" mass spectrometer is designed specially for measuring minute impurities in solid substances using the spark ionisation technique. It will be very useful in the preparation of materials of very high purity, for example, in nuclear engineering, semiconductor research and manufacture, and in the development of non-ferrous metals and alloys. Materials which have been successfully analysed down to 0·01 p.p.m. with the prototype model include uranium, "reactor grade" graphite, germanium, selenium, silicon, gallium-arsenide, magnesium, titanium, tungsten, iron, copper, aluminium, tin and nickel-chromium alloys.

First production version of "MS7" mass spectrometer

The "MS7" instrument mass spectrometer is a double-focusing equipment of the Mattauch type, in which positive ions, representative of the sample composition, are produced when a high-voltage spark occurs between two electrodes of the sample material placed closed together in vacuum. After passing first through an electrostatic analyser and then through a magnetic analyser, the ions come to focus according to their mass, but irrespective of their initial energy, as a series of lines on a photographic plate.

For the analysis of impurities in solids, the photographic plate is used as an integrating device, and a series of exposures of gradually increasing length are taken (a rack mechanism allows up to ten exposures to be recorded on the same plate and the exposure is accurately determined by the total integrated charge falling on the monitor collector). The concentration of the impurity is estimated from the intensity of the lines on the longer exposures, and with this technique concentrations down to the level of 0·01 p.p.m. can be estimated.

The method is useful for giving a general picture of the impurities in a solid. The whole mass range from 7–240, covering all elements, can be recorded in a single exposure of the photographic plate. Compared with emission spectroscopy, the spectra are simpler and the elements easier to identify. Moreover, qualitative and semi-quantitative analyses can be carried out without extensive calibration.

"MS7" instruments are now being produced for the National Physical Laboratory, the Services Electronics Research Laboratory, the Mond-Nickel Company and the U.K. Atomic Energy Authority. Orders are also in hand from France and America.

Aircraft and Equipment

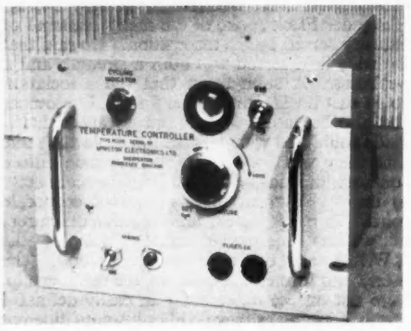
THERE was demonstrated recently at the Yeovil Aerodrome of Westland Aircraft Ltd. an example of their "Whirlwind" (S-55) helicopter modified to include a General Electric T-58 engine. The power section of the engine was turned to bring the exhaust to port and the drive shaft to starboard, and an angle gearbox made by de Havilland was used to join up with the centrally located drive intended for the steeply inclined piston engine. It is anticipated that it will prove possible to substitute a D.H. "Gnome" for the T-58: early marks of "Gnome" will not run continuously at large angles to the prevailing gravity field. It should be noted that this machine is not the equivalent of the S-62, which is an S-55 redesigned to exploit the T-58 and has a flying-boat hull to allow amphibious operations.

"Whirlwind" helicopter with G.E. T-58 power unit in place of piston engine

On the same occasion it was disclosed that Normalair Ltd. has under development a vapour-cycle refrigerating system for vehicles. The system is conventional in design, but it is claimed that the twin-cylinder compressor of 7 cu. in. capacity is particularly light and compact, thus facilitating its mounting direct on the engine that drives it.

Accurate Temperature Controller

A TEMPERATURE controller stated to be accurate within ±0·25 deg. Cent. at 1000 deg. Cent. is being produced commercially by Winston Electronics, Ltd., Shepperton, Middlesex, as a result of collaboration with United Steels, Ltd., of Rotherham. It is known as the Winston-United Steels "M226" temperature controller and it originated to meet the need for critical temperature control of furnaces used in the creep testing of alloy steels. It is designed to maintain the specified accuracy over long periods of continuous operation with negligible "down time": in three years' continuous operation with fifty-six prototype instruments the total time lost for maintenance was fifty-six hours.

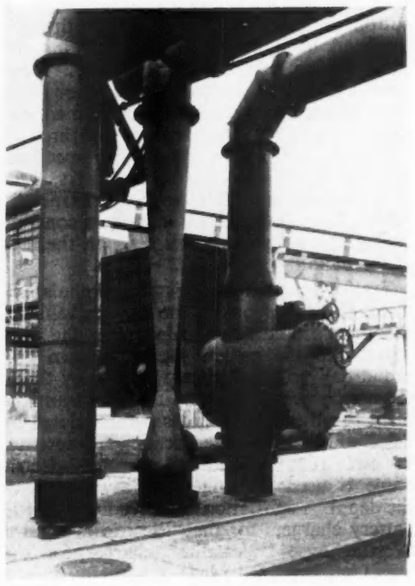


The M226 temperature controller is stated to be accurate within ±0·25 deg. Cent. at temperatures up to 1000 deg. Cent.

The basis of the controller is a platinum resistance thermometer formed into an a.c. powered Wheatstone bridge, the preset arm of which consists of a 1000-ohm potentiometer graded in 4000 steps, each being 0·25 deg. Cent. The out-of-balance voltage from the bridge is amplified by a two-stage amplifier giving a gain of approximately 2000. The amount of out-of-balance, that is, temperature error, is displayed by a "magic eye" indicator, having two degrees of sensitivity. The amplified output is also fed to a phase-sensitive bridge, which gives a positive or negative output according to whether the furnace temperature is lower or higher than the correct setting. This output is amplified ten-fold by the d.c. amplifier and then applied to one section of the relay controlling the furnace relay. A time interval generator provides switching cycles of, normally, thirty seconds to the other section of the relay control, which is so connected that the first section conducts, thus energising the relay, only when the control signal from the thermometer is more positive than the signal from the time interval generator. When the furnace is at the correct temperature, the relay is energised for one half of the time cycle. The switching of the furnace relay is used to alter the furnace current between two values chosen to match the furnace characteristics. The instrument is suitable for supplies of 200/250V or 100/130V a.c. at 40/100 c/s.

Pulsation Damper

OUR illustration shows two devices developed by the chemical engineering division of W. C. Holmes and Co., Ltd., to suppress fluctuations in the output pressure of positive displacement compressors : such fluctuations are frequently found blamed for fatigue failures of pipelines and plant. The furthest pipe incorporates a damper box : the cylindrical box itself contains fixed and movable perforated screens and gives on to an extension pipe, while the device also includes a by-pass. This apparatus has to be tuned for different gas flows by regulating the by-pass and moving one of the screens by means of the handwheels seen : this is simply done, but, nevertheless, burdensome.



Damper box and venturi installation at the Pleck works of the West Midlands Gas Board

To obviate the need for all routine attention, there has now been evolved the venturi vibration damper seen in the centre pipe. The venturi acts by drowning the pressure and velocity variations in the incoming gas in the large change in velocity and pressure in the convergent portion of the nozzle : the pressure energy is then almost completely recovered in the expansion section. More nearly steady flow would be expected if the nozzle ram choked, in which case density and temperature variations only could alter the flow rate, but the pressure differences needed in such a design are not practical. It will be noticed that the upstream part of the nozzle contracts much more gradually than is usual in wind tunnels.

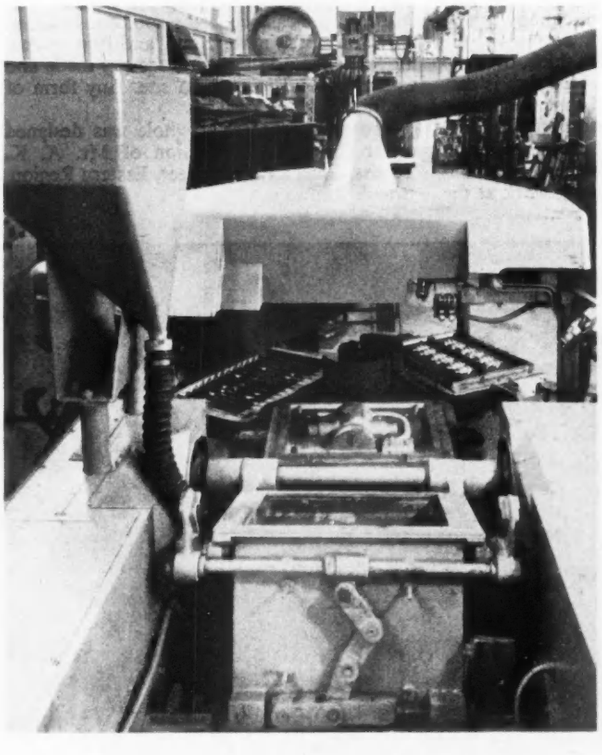
The examples illustrated handle 6,000,000 cubic feet of gas per day at a pressure of 2½ lb per square inch gauge, and impose a pressure loss of 1½in water gauge. The venturi installation has also run successfully at 10 lb per square inch gauge.

Shell Moulding Machine

AN automatic shell moulding machine made by Baker Perkins, Ltd., Peterborough, is designed to handle 18in by 12in patterns and has achieved a production rate of seventy-five 4 lb to 4½ lb shells an hour. The machine has three stations for pattern investment, shell curing and shell ejection respectively and for the fully automatic cycle two patterns are used.

The investment station of the machine can be seen in our illustration. Here the pattern plate is swung off the indexing gear and over on to the top of the dump box, where it is locked by a toggle mechanism. The dump box with the pattern plate attached is then swung over on its trunnion mounting and remains inverted. When the preset investment period has been completed the box swings back and the pattern plate on being unlocked is returned to the machine table. On indexing the inverted plate is carried into an oven station where the shell is cured before the next indexing movement. At the final shell ejection station, when the spring-loaded ejector pins have released a shell from the pattern, the shell is picked up by arms on an overhead carriage. The arms raise the shell clear of the pattern and the carriage traverses sideways to carry the shell out from the machine and deposit it on to a conveyor leading either to a storage area or a mould closing station. Between the ejection and investment stations is an equipment for automatically spraying a release agent on to the stripped patterns as they pass to the investment point.

A supply hopper at the side of the machine is connected to the dump box by a flexible tube, and a supply of sand/resin mixture from this hopper automatically tops up the box after each investment operation. It is stated by the makers that pattern changing can be carried out in about five minutes, and that once the time-cycle has been set, the machine can be supervised by an unskilled operator.



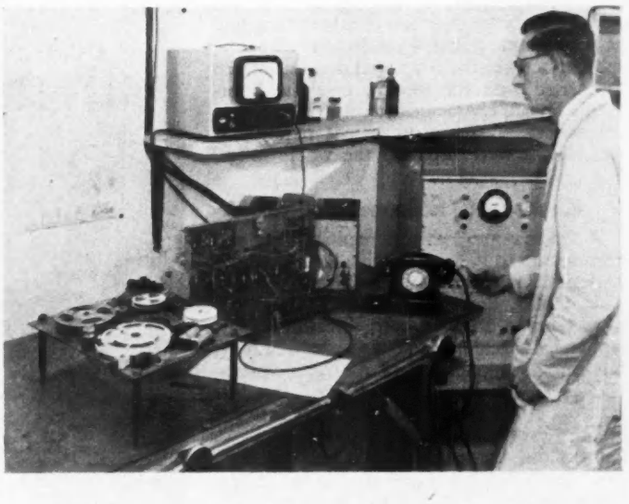
Automatic cycle shell moulding machine for 18in by 12in patterns

Telephone Answering Equipment

INCREASED message storage capacity is available in the " Ansafone " automatic telephone-answering and recording device made by Southern Instruments, Ltd., Frimley Road, Camberley, Surrey. Total recording time for messages is now one hour instead of thirty minutes as when the instrument was introduced at the beginning of the year, and " Ansafones " already in service can be converted to provide this extended playback.

In connection with the announcement of this new facility, we recently had the opportunity to see the instruments during manufacture and on test at the maker's works, where all the operations of making and spray-finishing the sheet metal cases are carried out, as well as the circuit assembly. The complete circuit, with its power unit, is carried on one chassis, and the tape desk with its answering and recording tapes is mounted above this on four support pillars at the corners, the whole forming a compact assembly suitable for desk or table when enclosed in its case. The operations of playing the answer tape, rewinding it and starting the recording tape are under the control of a single relay. On receipt of an incoming call the ringing pulses are rectified and charge a capacitor, which after a delay of some fifteen seconds discharges to operate a line relay. This connects the " Ansafone " to the line so that ringing stops and speech can be received and transmitted in the same way as if the telephone handset had been lifted. After the connection has been established, it is maintained by voice-operated switching circuits with a delay characteristic to allow for pauses in dictation. When the preset delay is exceeded, the condensers in the time constant circuits discharge so that the valves are biased beyond cut-off and the line relay is released, the telephone then being free to accept a further call.

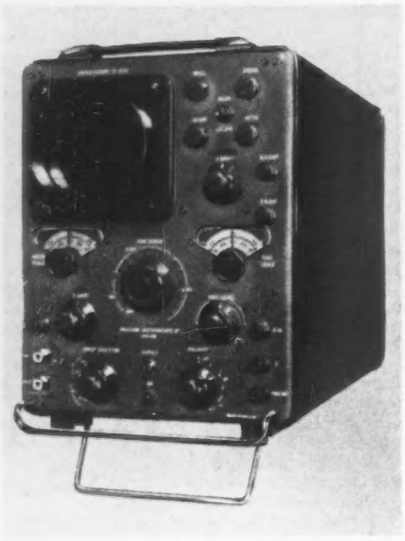
An indication of the amount of recording tape used is given by means of a window marked with a scale through which one of the spools may be seen. If less than three minutes' recording time remains, the " Ansafone " does not come into operation when the telephone bell rings. Shortly before recording stops due to the tape being fully used, a warning is transmitted to the speaker that the instrument is about to disconnect itself from the line.



Mechanical and electronic chassis of telephone answering device

General Purpose Oscilloscope

A NEW general-purpose oscilloscope has been announced by Marconi Instruments, Ltd., St. Albans. Frequency range extends from d.c. to 15Mc/s and sensitivity is variable in seven steps from 50mV/cm to 50V/cm. Timebase is variable from 1 sec./cm to 0.1 μsec/cm in fifteen ranges, and can be increased up to 0.02 μsec/cm using X expansion. The 5in cathode ray tube has a spiral post-deflection accelerator and operates at an e.h.t. of 10kV, these features having been incorporated in the interests of a linear high-brilliance display at fast writing speeds or low pulse repetition rates. The viewing hood round the screen of the tube can be removed for attachment of an oscilloscope camera unit. Controls are colour-coded and

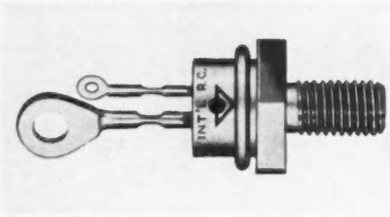


General purpose oscilloscope with colour-coded controls in a functional grouping and adjustable stand for upward or downward tilting

grouped for maximum operational convenience. A tilting stand is fitted below the front of the instrument. The oscilloscope is designated "TF 1330" and its development to meet the often conflicting demands made on a general-purpose instrument has been the subject of a study by special project teams set up in the company's factory. An example of the work undertaken is the special circuit devised for the sweep generator to combine the characteristics of the Miller and the bootstrap sawtooth generators in such a way as to obtain Miller linearity at very low speeds, but without the initial non-linear step associated with this circuit, and the bootstrap linear characteristic at high speeds without the bulky arrangement required if this circuit were used for the whole range.

Controlled Silicon Rectifier

A "TRIGGERED" silicon rectifier for load currents up to 10A is available from the International Rectifier Company (Great Britain), Ltd., Oxted, Surrey. The rectifier normally blocks up to 200V in both directions apart from a leakage current of the order of 12mA, but on the application of a trigger voltage of 5 to 10V to its third, or "gate," terminal it at once exhibits the extremely low forward voltage drop of a single junction rectifier, being about one-tenth that of a gas thyratron, and approximately 1·5V at 24 deg. Cent. Output voltage is controlled by varying the point in the half-cycle at which the device is made to conduct. A series of these rectifiers is made, with peak inverse voltage ratings of 20, 30, 50, 70, 100, 150 and 200V. All units are hermetically sealed and have an overall height of 1⅛in. Typical applications include



Silicon rectifier of 10A capacity with "gate" terminal for output control. Overall length is 1⅛in

motor and generator control, static switching, d.c. power regulation, heater and lamp control, constant current supplies, dynamic braking, welding control and voltage surge suppression. As an alternative to control through the gate terminal, there are some applications in which use may be made of the property of the device for rapid switching to the conducting state when the critical forward breakover voltage is exceeded.

New Goods Depot at Peterborough

A NEW goods depot and road motor depot opened at Peterborough on July 13 represents the first step in a programme of modernising the city's railway facilities by British Railways, Eastern Region. Accommodation is available in the goods shed and sidings for dealing with 116 wagons under cover and 185 in the open, 118 of the latter being in positions with road access. The shed has a concrete barrel roof, with plastic domes, covering an area 572ft long by 104ft 8in wide. Transverse concrete beams supporting the roof are cantilevered out 26ft 2in from the concrete columns along the whole of the east side to carry a flat slab forming a canopy, and similarly for four bays on the west side. The west side canopy can be seen in the illustration, and, beyond it, the flat concrete slab covering, 5in thick, over the loading dock and conveyor. This slab is carried on transverse prestressed concrete beams, 8ft 6in by 3ft 9in overall and 98ft 6in long, supported on reinforced concrete columns. Sir William Halcrow and Partners were consultants for the civil engineering work at the depot, which included the main shed, and the contractor for the goods shed and roadways was C. R. Price, Ltd.

The shed is fed by three tracks, two serving the conveyor and the third being used for throwout of wagons after they have been cleared. Movement of wagons alongside the conveyor for unloading is by means of three two-ton capstans supplied by Cowans Sheldon and Co., Ltd. The conveyor, manufactured and installed by Paterson Hughes Engineering Company, Ltd., is 331ft long and 3ft wide and has a fixed speed of 40ft per min. It is started and normally stopped by the shed foreman, but pendant stop buttons are provided at approximately 40ft centres along the platform for emergency use. The wiring to the push-buttons is taken to the tap-off points through overhead trunking which also supports the cold cathode interior lighting fittings. These were supplied by Ionlite, Ltd. Exterior lighting is by means of colour-corrected mercury-vapour lamps mounted in groups of three on three 50ft steel towers supplied to specification by Pirelli-General Cable Works, Ltd. This is supplemented at the shed entrance by further lamps in projector units on a concrete gantry spanning the tracks, and on the face of the building.

Traffic for despatch is "perambulated" direct to the wagons in the cartage vehicles. Incoming traffic is unloaded from the conveyor into the trailers used for town and radial deliveries, which are hauled by three-ton mechanical horses; or, if it is for transhipment to other wagons, it is perambulated by a fleet of Morrison "Electricars." A Ransomes 25 cwt runabout battery-operated electric crane is used for handling heavy loads in the depot. A substation with five Legg vehicle battery chargers for the "Electricars" and a Westinghouse "Westalite" charger for the crane has been provided.

Also on the site are a new road motor depot, office block and Mechanical and Electrical Engineer's office. These buildings were constructed by Gilbert-Ash, Ltd., and embody that company's "Inter-Grid" system of pre-stressed, pre-cast concrete roof construction based on a 3ft 4in horizontal and 10in vertical module. The grid units are factory made and assembled and jointed on site. Any form of cladding may be used.

The new depot as a whole was designed under the general direction of Mr. A. K. Terriss, Chief Civil Engineer, Eastern Region, British Railways.

View of Peterborough goods shed from the south end showing concrete barrel roof and lighting gantry in foreground

Industrial and Labour Notes

Iron and Steel

A survey by the Iron and Steel Board of the iron and steel industry's operation in the first six months of this year shows that, during the second quarter, steel production continued to improve and reached much the same level as in the comparable period of 1958. The annual rate of production over the first six months of this year was 19,321,000 tons for steel and 11,943,000 tons for pig iron. The latter figure was lower than that for the comparable period of last year mainly, the Iron and Steel Board says, because of the decreased use of pig iron in relation to scrap at the steel furnaces.

The increasing rate of steel production during the second quarter of this year, the Board explains, was brought about mainly by increased deliveries to the motor-car trade, to building and contracting, and to the wire manufacturing industry. Total orders on steelmakers' books, both for home and export, have been steadily increasing since February. There is still in progress a detailed examination of the likely long-term demand for steel in the middle 1960s and up till 1970. This examination was put in hand towards the end of last year. Reference to it is made in the Iron and Steel Board's annual report, which was published a few weeks ago. There it is stated that it will be some months before the examination is completed.

The Employment Situation

The latest report by the Ministry of Labour on unemployment in Great Britain shows that the improvement, which has been evident in recent months, continues. On July 13, the number of people registered as out of work was 394,793. Of that total, 20,884 were temporarily stopped and 215,301 had been unemployed for more than eight weeks. In the month ended July 13, there was more employment in most sectors of the engineering and " metal manufacturing " industries. The sectors of industry in which there has recently been less employment include mining and quarrying and paper, printing and publishing.

The Ministry says that during June the number of people in civil employment in Great Britain increased by 85,000 to a total of 23,020,000. The number of operatives working short time in the manufacturing industries at the end of June was 60,000. That was 22,000 fewer than at the end of May and 127,000 fewer than in June, 1958.

Factory Legislation

Before Parliament rose for the summer recess, the Factories Act, 1959, received the Royal Assent. This Act amends the Factories Acts of 1937 and 1948, and makes some further provisions for the health, safety and welfare of factory workers. Its three main objects are : to improve the existing provisions for fire precautions in factories ; to place on the Minister of Labour the duty of promoting health, safety and welfare, in those places which are covered by the Factories Acts, by collecting and disseminating information and by carrying out investigations ; and to revoke Defence Regulation 59, replacing it with a permanent but more limited power to grant exemptions from the law regulating the hours of employment of women and young people. Furthermore, the Act increases the maximum fines which can be imposed for contraventions of factory law and strengthens certain existing safety provisions, including those relating to dangerous substances and fumes, lifts and cranes and the maintenance of floors, passages and stairs. The Act also extends the scope of factory legislation to cover railway running sheds where running repairs are made on locomotives.

The Minister of Labour has stated, in a Parliamentary reply, that his intention is to bring all the provisions of the Act into operation at the earliest possible date. Subject to consultations with interested organisations, it is hoped to make about half the provisions effective from December 1. But certain other provisions, those concerned with fire precautions, for example, involve administrative changes affecting local authorities and the Factory Inspectorate. Consequently, these will have to be discussed with the local authorities affected before the date for their becoming effective can be determined.

Massey-Ferguson and Standard

At a meeting on August 28, the shareholders of Standard Motor Company, Ltd., will be asked to approve agreements concerning the transfer of tractor manufacturing facilities at Coventry and in France to Massey-Ferguson, Ltd. Massey-Ferguson, Ltd., is to acquire these facilities at an expenditure of £11,800,000. The most important of them is the Banner Lane plant at Coventry, which was designed specially for the production of Massey-Ferguson tractors and has a maximum annual output of 100,000 tractors. The two plants in France are at Paris and Beauvais ; their combined annual capacity is 25,000 tractors.

The arrangement is that Massey-Ferguson, Ltd., will take over full control of the Coventry establishment on September 1. To that end, the company has had discussions with representatives of the trade unions in order to allay any uncertainties on the part of Standard employees as to future terms and conditions of work. These discussions have also taken into account existing relationships with the trade unions at the Massey-Ferguson establishments at Coventry, Manchester and Kilmarnock, and at F. Perkins, Ltd., Peterborough.

Industry's Capital Expenditure

The Board of Trade has stated that, in the first quarter of this year, fixed capital expenditure by manufacturing industry was 12 per cent lower than in the corresponding quarter of 1958, while expenditure by " other industries and services " was 3 per cent higher. Taken together, these two industrial groups showed a fall of 6 per cent in their capital expenditure. The decrease of 12 per cent in manufacturing industry's capital expenditure in the first quarter of this year followed a 5 per cent decrease in the last quarter of 1958. It was due mainly to a larger decrease in expenditure on plant and machinery (12 per cent compared with 2 per cent) and partly to a larger fall in expenditure on building work (17 per cent compared with 11 per cent). Expenditure on vehicles —a small item in manufacturing industry— was 10 per cent higher in the first quarter of this year, compared with a decrease of 6 per cent in the preceding quarter. But it should be noted that these estimates include Government expenditure on research and development. If that expenditure is excluded, the rest of manufacturing industry, consisting almost entirely, of course, of the private sector, showed a decrease of 10 per cent in its expenditure in the first quarter, compared with a decrease of 3 per cent in the preceding quarter.

Tests for Engineering Apprentices

Among the reports that have reached us in recent weeks is one from the National Institute of Industrial Psychology entitled *Tests for Engineering Apprentices*. It has been prepared by C. B. Frisby, D. F. Vincent and Ruth Lancashire, and deals with selection tests which have been devised by the Institute. The information on which the report is based was provided by nineteen companies in various parts of this country, some of which had been operating the selection tests for several years and others for a relatively short period. These companies make a variety of products ranging from scientific instruments to heavy machinery, and the total number of apprentices trained, as well as the methods of training, varied considerably between one firm and another. There were some differences in the kinds of test used, but each company had used at least one verbal intelligence test, one non-verbal intelligence test, one spatial judgment test and one mechanical aptitude test. All but four of the companies had also used a test of manual dexterity and several included an arithmetic test.

The investigation preceding the preparation of the report involved an examination of the records of nearly 2000 apprentices employed at some time by the nineteen companies. From this examination, detailed statistical comparisons have been made between the apprentices' scores in the tests and their subsequent achievements at technical college and on the shop floor. These comparisons, the report says, show a marked relation between selection-test performance and later successes at technical colleges and in City and Guilds or National Certificate examinations. Of those with the highest scores in the tests, for example, more than four-fifths obtained their Ordinary National Certificate and a third the Higher National Certificate. Performance on the shop floor, it is added, was harder to assess accurately because it depended on the judgment of supervisors.

The Institute's inquiry also brought to light a connection between the educational background of some 900 of the apprentices and their attainments in technical examinations. Among boys who had been to grammar schools, 22 per cent of those following the National Certificate course gained the ordinary certificate and 28 per cent of those taking City and Guilds courses passed the final examination. A similar proportion from secondary technical schools gained the ordinary certificate, but fewer of those taking City and Guilds courses reached the final. The report goes on to comment that boys from secondary modern schools did not do so well as the others in the higher examinations though they were better than the grammar school boys in the City and Guilds intermediate examination. The proportion of boys from grammar and technical schools with no academic achievement at all was about the same, but among the secondary modern schoolboys it was " far greater."

Tancarville Suspension Bridge

After a construction period of just under forty-four months, the suspension road bridge across the mouth of the River Seine at Tancarville was handed over to traffic on July 3. With a centre span of 608m and two side spans of 176m each, it is the longest bridge in Europe and the ninth longest in the world. For the first time in a structure of this kind, the towers were constructed of concrete. Measures to ensure stability in strong winds include the building of the deck as a continuous torsionally rigid beam, and rigidly connecting the suspension cables to it at the centre of the main span.

FOR many years the lack of a bridge along the whole of the 125km of the Lower Seine between Rouen and Le Havre was felt to be a serious deficiency, the existing ferries providing only a very inadequate substitute. Already in 1870–71 it had been proposed to take the railway across somewhere along the lower reaches, and the various suggestions included a viaduct, tunnel, traverser, ferry-boat, and an underwater bridge carrying a traverser. Opinion eventually settled in favour of the tunnel, but lack of money caused the scheme to be finally abandoned in 1931, in the midst of the economic crisis.

Several years earlier, in 1924, the growth of road traffic led the Service des Ponts et Chaussées of the Department of Seine-Maritime to work out preliminary plans for a suspension road bridge. That there was a real and continuing need for crossing facilities was shown by the fact that when a large new ferry was put into service in 1932 between Hode and Berville, some 20km from Le Havre, although from the start it attracted an important volume of traffic it did not draw away traffic from the ferries situated further up river.

Towards the end of 1935, the Chamber of Commerce of Le Havre applied to the Government for a concession to build and operate as a toll-bridge a road bridge at Tancarville. The work was subsequently declared to be of public importance, and some earth moving was carried out during 1940–45 as part of a scheme to provide employment, but the bridge itself had to be left in abeyance. It was only in 1951 that the Chamber of Commerce of Le Havre finally secured the concession. A design competition was held the following year and as a result a group of twelve firms was entrusted with the work. Between November 15, 1955, and March 23, 1956, site facilities were constructed, after which the work began with the driving of piles for the access viaduct on the left bank. Some difficulty was caused in the sinking of the large caisson for the foundation of the left bank tower by the waterlogged soil. By speeding up the subsequent construction of the tower, however, it was found possible to maintain the schedule. The tower was completed on March 14, 1958, and between that date and August 17, the suspension cables were placed in position at the rate of four to five cables per day. Following this, the suspenders could be placed in position and the erection of the bridge deck commenced, a task which was completed on April 15 of this year. The final two and a half months were occupied with placing the concrete of the roadway and the bituminous surface, installing lighting, regulating the suspension, and completing the right bank access and the toll-booths situated there. The bridge, shown in Fig. 1, was eventually put into service on July 3, eight days before the contract date.

The Tancarville bridge provides a crossing between the steep and hilly right bank and the low-lying, flat left bank, involving a total length of 1400·2m of which 960m are occupied by the suspension bridge itself consisting of a main span of 608m and two side spans of 176m each; the concrete approach viaduct on the left bank comprises the 40·2m long anchor block and eight spans of 50m each, with a gradient of 1 in 14·65, the level of the beginning of the viaduct being reached over an earth embankment.

In order not to impede the seagoing traffic on the Seine into and out of Rouen, a clearance under the centre of the main span of 50·85m had to be provided. This is reckoned from the highest water level, taken as +9·15m. The two towers carrying the suspension cables stand on shore so as to keep the whole width of the river free from obstruction. While the height of the deck necessitated on the left bank an elaborate approach structure, the other end of the bridge rests directly against the hillside, the side span bridging the foreshore and lower slopes. In consequence, only a small embankment was required here to bring the road up to the level of the bridge.

The site chosen has another advantage, in that it avoids necessity of having to provide a secondary crossing of the barge canal which extends along the Seine from the port of Le Havre to Tancarville. Altogether, the design may be considered both economic and elegant. The cost of the bridge itself, excluding ancillary road work, is moderate and amounts to about 8000 million francs.

Towers

On the right bank of the river, the tower foundation consists of two caissons of reinforced concrete 12m by 12m in section (12·20m by 12·20m at the cutting edge) and 18·50m high, sunk from ground level at +10·40m sea level to −9m sea level. These two caissons were spaced at a distance, transverse to the direction of the bridge, of 24·65m between centres.

Each caisson has a 2·25m high working chamber at the bottom, followed by an 8m high section in which are formed three by three circular cavities of 3m diameter. Above this section, the 0·50m thick outer walls were carried up 8·30m. The downstream caisson was sunk as an open caisson while the other had to be sunk as a pneumatic caisson between −1·58m and −9m sea level. Both rest on the local calcareous marl.

The bars of the two halves of the tower were encastred in the top section of the caisson where an 8·30m thick concrete slab was cast containing the ends of the tower reinforcement rods, some at a depth of 3m, others at 5·50m.

On the left river bank conditions were much less favourable. Here a single caisson (Fig. 2) was employed which had to be sunk through a layer of silt to a bed of sand and gravel at −19·0m sea level, making the overall depth 28m between the top surface of the caisson at +9m, slightly above ground level, and its base. The caisson measures 34·45m by 12·30m and comprised ten cavities 3·92m by 5·23m which after sinking the caisson were filled with concrete. The top comprises an 8m-thick slab of concrete in which are encastred the footings of the tower.

Before the caisson could be commenced it was necessary to drive a 42m diameter circle of sheet piling to −7·5m and inject the soil round the caisson area with cement. Forty-six holes were brought down to −19m, and about 30 tonnes of cement injected through each. The top layer of silt was excavated to a depth of 4m and replaced by firm soil which was well compacted. This provided secure guidance for the top of the caisson during the sinking, which was carried out by the open method to −14m and under compressed air for the final 5m.

Both the towers consist of two upright reinforced concrete members encastred at the base and joined by a concrete web below the level of the bridge and a similar but slightly arched web near the top. The height of the right bank tower (Fig. 3) amounts to 123·4m above the top of its foundation at +9·5m sea level, that on the left bank stands 121·9m high above its foundation at +9m.

Each upright is rectangular in section, tapering from 4·65m by 6·55m at the base to 4·65m by 3m at the top, the width in the longitudinal direction remaining constant; between the ground and the deck the outside face of the concrete slopes inwards at an inclination of about 1 in 347, above this level the inclination is approximately 1 in 163. The centres of the uprights are 24·70m apart at the base and 16m at the top. A central chimney 1·2m by 1·2m is left giving access over ladders to the top web. The lower web is 0·60m thick and broadens below the bridge deck into a beam 2·20m wide and 3·50m high, on which rest the roller supports for the steelwork. Vertical reinforcement consists of 50mm diameter rods of "AC65" steel and horizontal reinforcement of 20mm diameter rods of "AC42" steel, while the webs are reinforced with 32mm and 24mm bars.

The quantities for the towers and their foundations are shown in Table I.

The forces acting on each of the uprights of either tower amount to 15,000 tonnes with a fully adjusted suspension and 17,000 tonnes under full load. The maximum combined dead and working load on the base of the foundations of the left-bank tower is 50,000 tonnes,

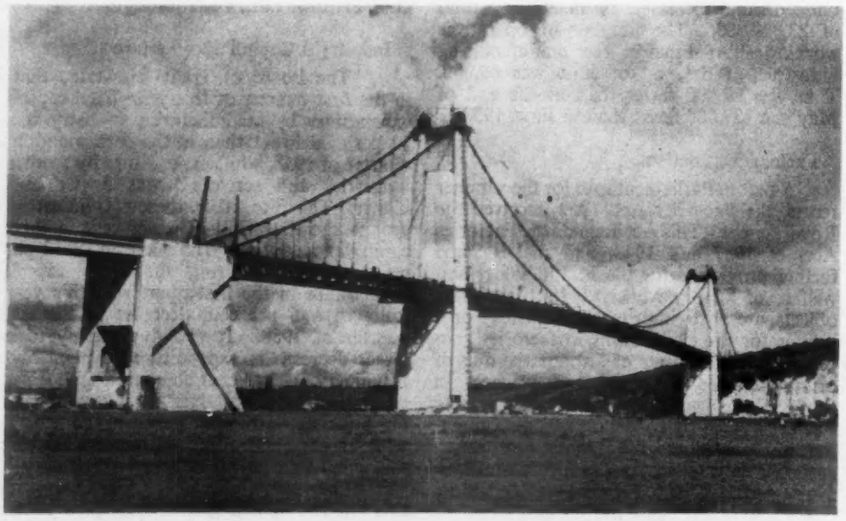


Fig. 1—Tancarville bridge nearing completion. The left bank anchorage structure and the last span of the approach viaduct are seen on the left. Note also the cableways and suspension cranes between the towers. By attaching the suspension cables to the bridge deck at the centre of the main span and making the superstructure continuous and rigid in torsion, a high degree of wind resistance is obtained

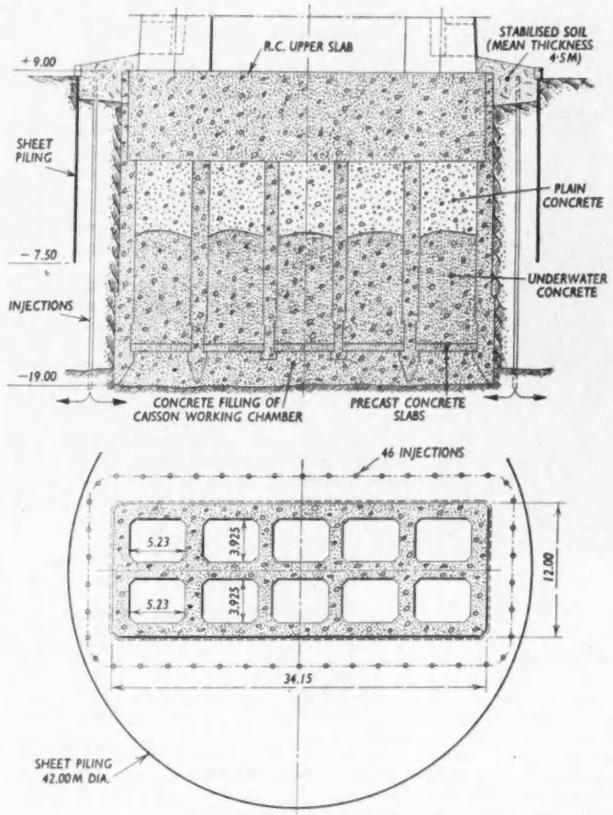


Fig. 2—Foundations of left bank tower

equivalent to a ground pressure of 16 kg per square centimetre.

TABLE I—*Towers and Tower Foundations*

	Right bank	Left bank
Foundations :		
Excavation, cubic metres	5,800	11,900
Reinforced concrete, cubic metres	5,500	7,230
Reinforcement steel, tonnes	385	650
Concrete filling of caisson, cubic metres	3,330	
Towers :		
Total concrete volume, cubic metres	11,600	
Total reinforcement steel, tonnes...	1,600	

Under the most unfavourable conditions, the deflection at the top of the towers amounts to 41cm, of which 9cm are due to temperature variations. The maximum stress induced at the base in those circumstances is 98 kg per square centimetre.

Suspension

The two suspension cables each consist of a bundle of fifty-six elementary cables of 72mm diameter and 1060m long between anchors. For the side spans the number of constituent cables is increased to sixty.

Each of the elementary cables is made of 169 wires of 4·7mm diameter of 150/160 kg per square millimetre steel. The maximum stress in the steel is 50 kg per square millimetre.

The subsidiary cables are arranged in a quasi-hexagonal array 55·6cm high and 56·4cm broad, the side span section taking the form of two trapezia, each being the other's mirror image about the horizontal mid-plane and comprising five rows of from eight to four cables ; along the central span the top row of four cables is omitted, these cables being anchored in the saddle plates at the top of the towers. These saddles are heavily ribbed-steel castings, with a cable channel of 4·50m mean radius and a 4m long and 2m broad flat base, running on eighteen rollers. After passing over the anchor sill the suspension spreads out, each elementary cable being attached to the anchor by its socket by means of three studs cast into the concrete, each 68mm in diameter and 6m long.

The suspenders consist of single cables of 89mm diameter, each containing 261 wires of 4·7mm diameter made of 150/160 kg per square millimetre steel. There are 170 suspenders pitched at a distance apart of 10·667m. The stress in the suspender cables is limited to 30 kg per square millimetre. The clamps are cast steel and weigh over 2 tonnes apiece.

Superstructure

The superstructure (Figs. 4, 5 and 9) of the bridge consists of two girders at a distance of 16m between centres and continuous over the whole length of the bridge deck, and the lower wind bracing. The stiffening girders have an overall height of 6m. Their top and bottom flanges are carried out as box structures, and are connected by diagonal and vertical members in the form of a modified Warren girder with a vertical member rising from each of the lower nodes. The top flanges are connected by the 10mm thick steel deck on which is placed the 9·5cm thick reinforced concrete deck slab with a top facing of bituminous concrete 4cm thick over the 12·50m wide roadway, which is adjoined on either side by a 1·375m wide raised footpath.

The lower flanges of the stiffening girders are cross-braced in trellis fashion to provide additional stiffness against wind forces. The vertical girder members are situated at 10·667m pitch below the points of attachment of the suspender cables. To one side of each of these members is connected a 1·6m deep transverse plate girder to support the deck. These girders are supplemented by seven equally pitched longitudinal plate girders of 10·667m span.

The combination of stiffening girders with an intrinsically stiff deck and with the lower wind bracing constitutes a quasi-tubular structure of great torsional rigidity.

As has been mentioned, in order to further increase the stiffness of the system, attachments are provided at the mid-point by which the suspension cables are clamped directly to the top flanges of the stiffening girders without intermediate suspenders.

The whole of the bridge steel structure weighs 7500 tonnes and is riveted.

The working stress permitted in the lower flanges of the stiffening girders, which are of "Ac 55" steel, is 22 kg per square millimetre ; that in the upper flanges and diagonal member (made of "Ac 42" steel) is 16 kg per square millimetre. The dead load amounts to 16 tonnes per metre, or about 400 kg per square metre of useful deck surface (road and two footpaths). At the centre of the mid-span the combined effects of live load and temperature (±27 deg. Cent.) can cause a vertical deflection of up to 2·60m, while a wind force of 250 kg per square metre produces a horizontal deflection of 1·26m at that point. Model tests have indicated a frequency of oscillation with one node of fifteen vibrations per minute and a torsional fundamental of sixty-two per minute.

Right Bank Anchorage

On the right river bank, where the end of the bridge reaches the hillside and the substratum consists of calcareous marl, the suspension cables were anchored to two parallel inclined concrete stalks connected at their lower ends by a transverse anchor beam. At ground level the cables lie on sill structures supported on separate foundation. These also carry two vertical ties pin-jointed at their ends to the base and the end of the bridge respectively ; these hold down the bridge while leaving the end free to move horizontally. Since movement of the bridge can amount to as much as 40cm in either direction, the resulting gap between the deck and the fixed roadway is bridged by a number of plates linked together to form a track and sliding in downwards-carrying rails. The remaining small gap is covered over by a lip plate fixed to the sill.

The two right bank anchorages (Fig. 6) extend from the end of the bridge at 59·24m sea level downwards into the hillside at an angle of 25 deg. 24 minutes to 22·53m sea level. The first section consists of a chamber lined with reinforced concrete in which the elementary cables of the suspension are spaced out. This is followed by a 9·65m long concrete plug, approximately 5m wide and 10·5m high on which the cable ends are anchored by their sockets as described. Each plug is continued as a hollow concrete stalk for a length of 40m, most of it of a section 4·63m high and rounded at the top and 3·7m wide, of 12·70 square metre section, allowing for a central inspection gallery 2·33m high and 1·5m wide, accessible from the surface through vertical shafts at either end. The two plug and integral stalks are each prestressed to 9600 tonnes by 120 cables of twenty-four wires of 7mm diameter. Spaced 16m apart, the stalks are joined at the lower end by a transverse anchor block 32m long and 9·5m high, owing to the presence of which the pressure on the chalk is limited to 6 kg per square centimetre. Numerous faults were found in the rock at a distance of 2m to 5m and generally filled with broken marl. These faults extended in a vertical direction east to west, intersecting the axis of the bridge at 30 deg. In the region of the anchor block the rock was made sound with the help of injections of cement.

Because of the slope of the hillside the two sill structures are founded at different levels, the up-river structure at +44m, the other at +34m ; their bases are rectangular and measure 11·8m by 6·4m and 13·3m by 8m respectively along and across the bridge. The effective ground pressure of these blocks of concrete does not

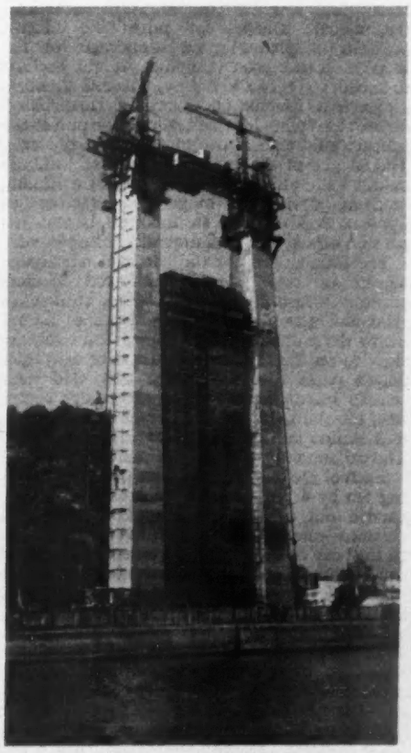


Fig. 3—Construction of the tower on the right bank. Sliding shuttering was used, a section 2m high being cast every three days. The scaffolding on top is raised as the work proceeds. It is reached by the two lifts on the outer tower faces. The heavy beam for supporting the superstructure and the web joining the uprights are being cast

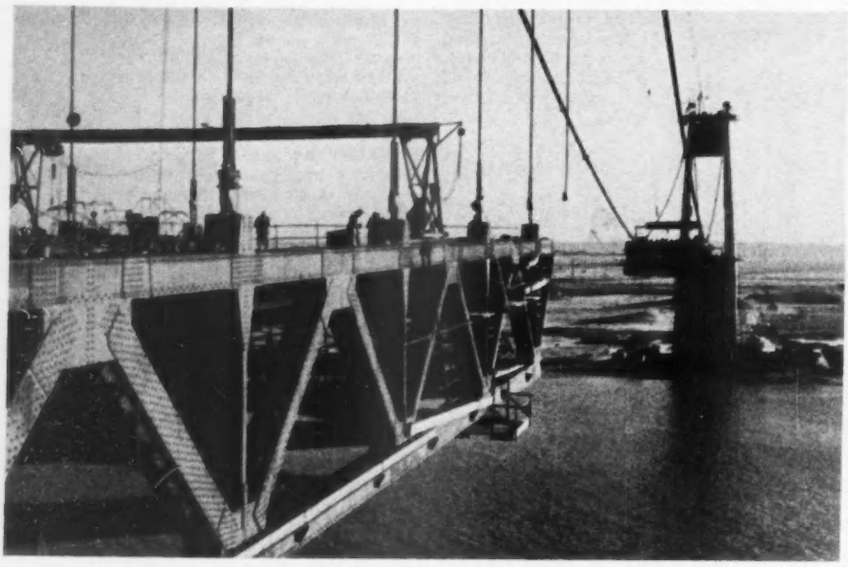


Fig. 4—Bridge superstructure being erected

exceed 8 kg per square centimetre. The data for the right bank anchorage are summarised in Table II.

TABLE II—*Anchorage on Right Bank*

Total tension exerted by suspension :	
(*a*) When fully regulated, tonnes	16,000
(*b*) With effect of temperature superimposed, tonnes...	11,360
Excavation of galleries, cubic metres	4,300
Excavation of access shafts, cubic metres	500
Underground concrete, cubic metres	3,600
Concrete sill blocks, cubic metres	2,000
Steel for prestressing cables, tonnes	117
Plain reinforcement steel, tonnes	80

Left Bank Anchorage

On the southern bank of the Seine, the bridge deck terminates at a height of over 47m above ground level, so that an approach viaduct of considerable length is required. At the same time, the insecure alluvial soil posed the difficult problem of providing an anchorage for the suspension cables on that side. It was decided to anchor the cables to a heavy concrete structure hinged to its foundations in a transverse direction on the side facing the river, so that the pull of the cables would tend to overturn it about this axis. The weight of the structure, together with the ballast with which it is filled, applies a turning moment about the hinge counteracting an opposite moment due to the pull of the suspension cables. Fig. 7 shows this arrangement.

The foundations for the left bank anchorage consist of three similar reinforced concrete caissons measuring 22m by 7·9m, resting on sand and gravel at −14m, a depth of 22·5m below the ground. Two of these, 22m high, are situated on the side towards the river with their length parallel to the bridge axis, and their centres 8m on either side of the bridge centre line, the third, 22·5m high, is on the land side, and stands at right angles to the bridge axis. The caisson centres are at a distance of 53·08m.

Each of the caissons had three cavities measuring 5m by 4·5m through which excavation was carried out by means of a grab. The front caissons—those towards the river—were sunk in this way as open caissons, except for the final 2m, for which compressed air working had to be used. A working chamber was installed by divers positioning three precast reinforced concrete slabs as ceiling. After sinking, the underlying soil was consolidated by fifteen injections of cement. The working chambers were filled with concrete under compressed air, and the first 6m of each cavity were filled with underwater concrete, the remainder with ordinary mass concrete. The land side caisson, which had no working chamber installed, was filled with 7m of underwater concrete, and the top section with sand. Heavy reinforced concrete caps were placed as seatings for the front hinges and rear bearings.

The concrete superstructure stands 47·17m high at the front end and 44·56m at the rear end, and measures 46·23m between the front hinges and the heel, and 20·2m overall width. It consists of two 4·2m thick side members at 16m centres astride the bridge axis, resting on the front caissons by means of a Freyssinet hinge, each 0·60m thick and 7·4m long. The top portion contains the cable chambers. Webs 1·30m thick form the remainder of the side walls as well as the wall connecting the two sides and the ballast chamber of 2114 cubic metres. On top between the two side walls is the 12·50m wide carriageway with pavements on either side.

The suspension cables rest on the top of the anchorage on two cast steel saddles from which the elementary cables spread out into the cable chambers, at the back of which they are fixed to the concrete by 68mm diameter anchor bolts of low-alloy steel embedded in the 4·2m thick concrete.

In connection with the Freyssinet hinges laboratory tests were carried at the Laboratoire du Bâtiment et des Travaux Publics, in which a half-scale model was subjected to a total load of 2600 tonnes, representing a compression of 453 kg per square centimetre. Several deflections by $^{1}/_{100}$ radian were carried out at this loading without causing any deterioration of the concrete. Under actual operation the load on each bearing is 14,500 tonnes or 323 kg per square centimetre on the bearing itself.

For the support of the superstructure at the heel a novel design of " Neoprene " pad bearing was adopted. Each of the two bearings is 2·08m wide, 3·6m long and 0·95m high, and comprises a central cylindrical biconvex lens of concrete between two plano-concave concrete lenses on each side with 2·29cm thick " Neoprene " in the interstices. The plastic is vulcanised on either side to 1mm thick sheet steel. During construction the heel has had to support 16,000 tonnes ; after completion of the bridge this was reduced to 10,000 tonnes. The pad bearings are designed to undergo a horizontal displacement of ±4cm, and a rotation of 0·4 per cent.

Table III shows a summary of the quantities for the left bank anchorage :

TABLE III—*Left Bank Anchorage*

Foundations :	
Excavation	12,300 cubic metres
Reinforced concrete	7,400 cubic metres
Concrete fill of caissons...	2,900 cubic metres
Reinforcements	700 tonnes
Maximum soil pressure (at front caisson edge)	21 kg/square centimetre
Superstructure :	
Plain reinforced and prestressed concrete	12,500 cubic metres
Ballast filling (weak concrete)	2,114 cubic metres (= 4,500 tonnes)

Access Viaduct

The 400m long left bank access viaduct, a typical section of which we show in Fig. 8, rests on pile foundations consisting of prefabricated reinforced concrete piles of square section, a length of 21m being used for the first four piers

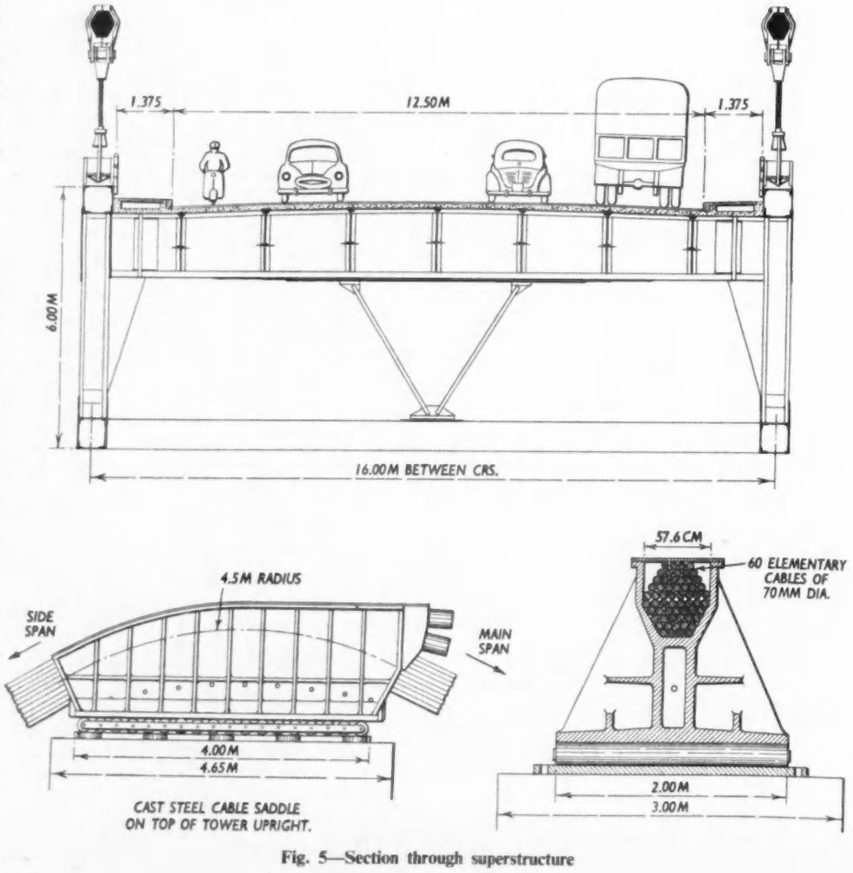


Fig. 5—Section through superstructure

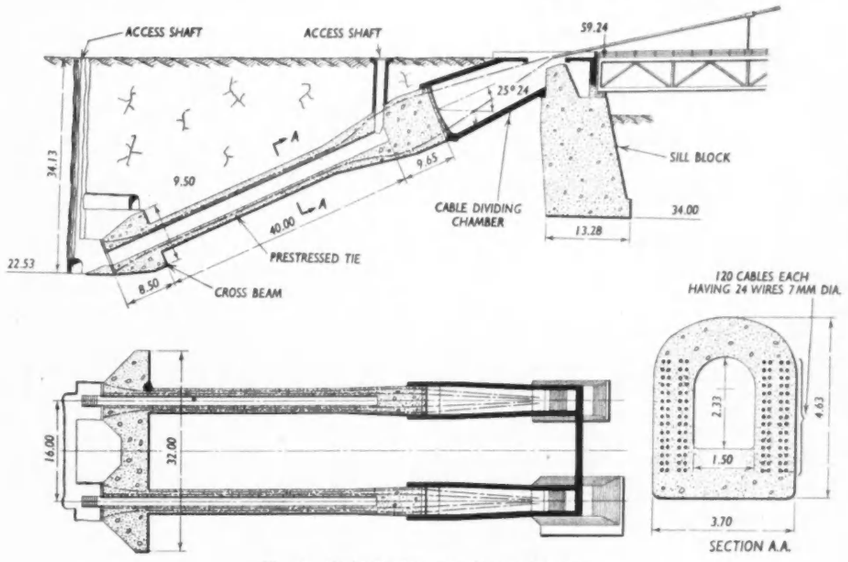


Fig. 6—Right bank suspension anchorage

and 22m for the last three. These piles, some of which were rammed straight and others at an angle, extend with their points into the sand and gravel which underlies the silt. They are loaded up to 130 tonnes and contain 160 kg per cubic metre of reinforcement. The heads are embedded over a length of 1·2m into a 2m thick capping slab measuring 5·5m by 16·00m, with its top surface at +9·4m, i.e. 1m below ground level.

Seven piers were constructed on these foundations, in the form of hollow reinforced concrete structures of 0·20m wall thickness and a uniform width of 14·80m. Their height increases from 16·09m to 35·59m and their thickness depending on height is either 2m, 2·50m or 3m. The top is a plain solid concrete 1·15m, 1·30m or 1·60m thick, according to the height. The end structure, between the earth embankment and the viaduct, comprises the last main pier, together with two rows of two columns 0·70m by 0·70m thick on a 2m thick piled foundation slab. The pier and the first column on each side are connected by two horizontal concrete beams 0·30m by 0·50m, and the two columns in each row by heavy concrete beams at the top on which rests the 0·18m thick prestressed and ribbed concrete deck which, at the lower end, is 14·68m above the top of the foundation. The end of the earth embankment slopes down from this point as far as the first pier and partly buries the supporting columns.

The eight 50m long spans of the approach viaduct on the left bank are each constructed of five prestressed concrete beams. These beams are 3m high, 1·2m wide at the top flange and 0·60m at the bottom flange, with a 0·16cm thick web, and have twenty-two prestressing cables, each of twelve wires of 7mm diameter, eight of which are taken out through the top surface.

Prestressing was carried out in two stages. Three weeks after casting, fourteen of the twenty-two cables, viz. those passing through the end faces, were tensioned, giving the beam a slight upward camber so that it detached itself from the mould and rested only on its ends. It was then transported to the foot of the piers. The tensioning stress in the steel amounted to 120 kg per square millimetre.

Each beam weighs 120 tonnes and was stressed to a maximum tensile stress of 187 kg per square centimetre at the bottom face. This figure occurred during tensioning, while *in situ* and under load it is reduced to 126 kg per square centimetre.

From the precasting area the beams were taken to the foot of the piers by a rail-mounted traverser. Jib hoists mounted on top of the piers were used to lift them into position. The beam ends rest on top of the piers on five layers of 5mm thick "Neoprene," allowing a movement of ±20mm. The spaces between them were filled by 0·2m thick transverse distance pieces cast *in situ*, sets of four tensioning cables being passed through these pieces and through holes left in the beams for the purpose, and an 18cm thick slab, also cast *in situ* and tensioned by a single layer of cables. A cambered 12·5m wide deck was then cast *in situ* and the remaining eight cables in the beams (those passing through the top flange) were tensioned. Details of the quantities are shown in Table IV.

TABLE IV—*Access Structures*

Reinforced concrete for piles, cubic metres	1,015
Reinforced concrete for foundation slabs, cubic metres	1,144
Reinforced concrete for piers and end structure, cubic metres	2,156
Steel reinforcement, tonnes	395
Earth volume of embankment, cubic metres	76,000
Main girders :	
Span, metres	50
Concrete, cubic metres	50
High-tensile steel for prestressing cables, kg	3,563
Other reinforcement, kg	2,707
Viaduct :	
Total precast concrete for girders, cubic metres	2,000
In-situ concrete (transverse beams and deck slab) cubic metres	900
High-tensile steel for cables, tonnes	180
Other reinforcement, tonnes	155

Model Tests

As is usual with structures of this importance and complexity, model tests were carried out in order to verify the principal design calculations. The effect of dead and live loading was demonstrated by means of a model to scale 1 in 100, in which the beam was represented by a carefully selected board of Canadian spruce with parallel fibres and free from knots, the section being such as to maintain similarity of the product *EI*. The suspension cables were made of the same wires as those of the real bridge. Both the table and suspension were loaded by adding small blocks of iron so as to maintain similarity of loading. Both the suspension and the deck were supported in the manner corresponding to the real bridge, i.e. at the top of the towers the cables were taken over pulleys fitted with ball

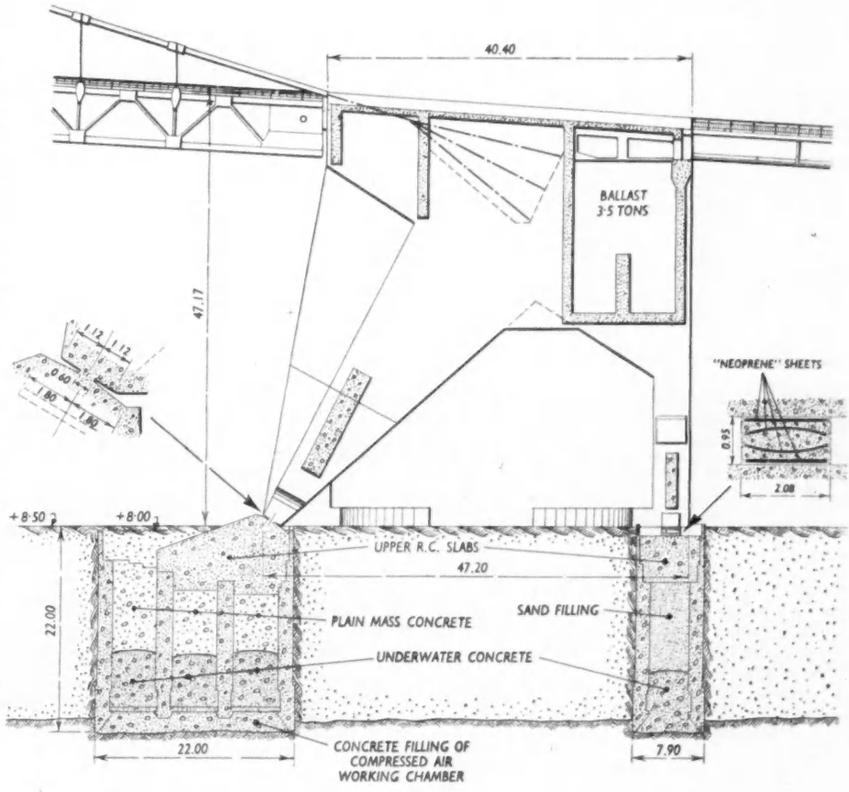


Fig. 7—Left bank anchorage structure

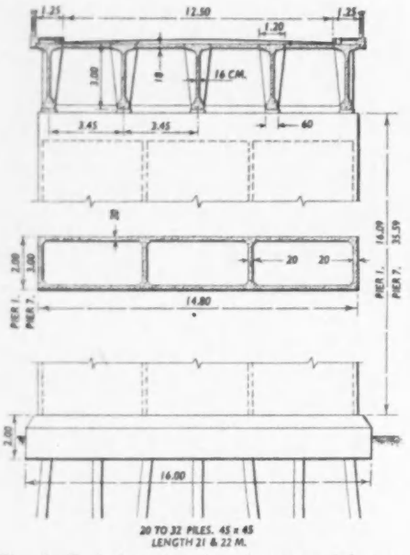


Fig. 8—Typical section through access viaduct on left bank

bearings and the deck was anchored at the end representing the right river bank by pin-jointed vertical ties, and rested on roller bearings at the towers. At both ends of the cables, and at the left bank end of the deck, lever balances were installed so as to measure the tension in each half-suspension on either side, and the forces in the deck. The bending moments were obtained from measurements of the curvature, and the deflections by direct measurement with dial gauges reading to 0·001mm. Additional blocks of iron could be suspended from the underside of the deck to represent to scale the live load, amounting on the real bridge to up to 5700 tonnes of vehicles.

Good agreement between the calculated and experimental values was obtained for the maximum bending moment diagram, the deflection of the deck and the forces in the suspension cables.

In order to verify the theoretical behaviour in a strong wind, a section of the deck, representing 120m of the span on a scale of 1 in 100, was tested in a specially built wind tunnel at the Ecole Normale Supérieure. This tunnel had an elliptical working section of 120cm by 80cm, and its air speed could be varied between 15m per second and 30m per second.

The model was held in a spring suspension representing vertical support or rotation about the longitudinal axis. Coupling between bending and torsional oscillations occurred at a critical speed corresponding to over 200m per second on the full-scale bridge, i.e. about four times the highest wind velocity observed at Tancarville.*

* L. Chadenson, "Essais sur les Théories Aerodynamiques Relatifs aux Ponts Suspendus et Leur Application au Pont de Tancarville," *Annales des Ponts et Chaussées*, Nos. 1 and 2, 1957.

Approach Roads

A substantial amount of road construction became necessary in connection with the new bridge. This included 10km on the right bank to link up with the Le Havre-Bolbec road, and a 1·5km stretch to connect with the direct road from Le Havre to Tancarville. On the left bank two roads were built across the alluvial plain of the Marais Vernier : a 6km long connection with the existing main road south of Guilleboef, and, to the west, a connecting system totalling 20km to cross the River Risle and join up with roads to Caen, Honfleur and Pont-Audemer. These roads required an earth movement of over 920,000 cubic metres and their combined surfaces amount to just over one-third of a million square metres.

The principal quantities of materials are summarised in Table V below.

Table V—*Principal Quantities*

Concrete :	
Access viaduct, excluding pile foundations, cubic metres	7,150
Access viaduct piles, cubic metres	1,015
Concrete bridge deck, cubic metres	1,750
Left bank anchorage :	
Superstructure, cubic metres	14,900
Foundations, cubic metres	9,750
Right bank anchorage, cubic metres	7,700
Towers :	
Superstructure, cubic metres	11,600
Foundations, cubic metres	16,950
Total volume of concrete, cubic metres	70,815
Steel :	
Rolled structural steel, tonnes	7,400
Rolled structural steel for subsidiary work, tonnes	236
Cast steel, tonnes	1,110
Forged steel, tonnes	320
Suspension cables and suspenders, tonnes	3,334
Castings and pipes, tonnes	32
Reinforcement bars, tonnes	5,990
Prestressing cables, tonnes	462
Total steel tonnage, tonnes	18,875

Main Contractors

The project of the Tancarville bridge was carried out by a group of twelve companies comprising the following firms : Baudin-Chateuneuf, Boussiron, Campenon-Bernard, Daydé, Compagnie de Fives-Lille, Société des Forges et Ateliers du Creusot, Fougerolle, Société Française d'Entreprise et de Dragages et de Travaux Publics, Regie Générale de Chemins de Fer et Travaux Publics, Entreprises de Grands Travaux Hydrauliques, Compagnie Industrielle de Travaux and Compagnie Française d'Entreprise.

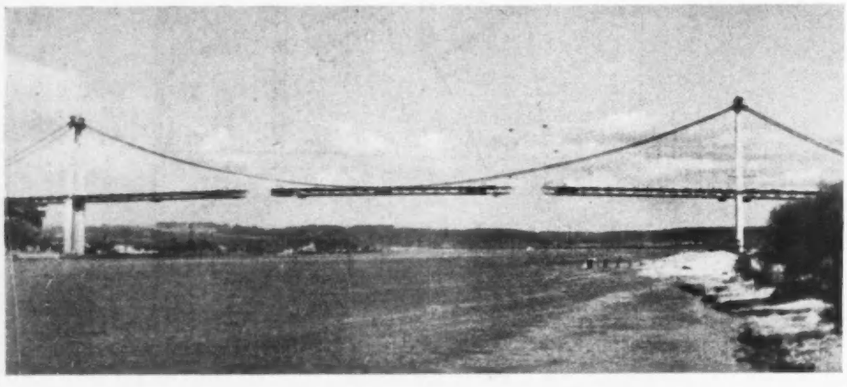


Fig. 9—Superstructure nearing completion. The bridge here is seen from downstream

E.C.S.C. Coal Industry

Coal stocks in the European Coal and Steel Community increased by 3,450,000 tons in the first three months of this year, and by a further 2,270,000 tons in April. Thus, at the end of April —i.e. at the end of the winter—the Community found itself with a stock of over 30,000,000 tons of coal at pitheads and nearly 8,000,000 tons of furnace coke, spread in varying degrees over practically all producing areas. The Federal Republic increased its stocks by 990,000 tons in that month, followed closely by France with a rise of 877,000 tons in its stocks. The rise in total stocks, slightly greater than the increase for the last quarter of 1958, took place in spite of an improvement in coal exports to third countries. Internal demand fell again—by about 5 per cent in comparison with the last quarter of last year—and this was a greater fall than normal between the two periods. A fall of 3 per cent in the consumption of coal in the countries of the European Coal and Steel Community in the summer months of this year as compared with the same period last year is forecast. The reduction, which will extend to public, industrial and domestic users, with the single exception of power station requirements, is expected to lead to a further rise in stocks of the order of 2,000,000 tons.

Forecasts of production in the Community, which do not take into account the effect of further short-time working, suggest a total of 58,900,000 metric tons, 1,300,000 less than the corresponding period (July to September) last year. Imports from non-Community countries, which are expected to reach 4,400,000 metric tons, show a marked reduction from the level of 1958, and are likely to be some 2,000,000 tons less than imports in the first quarter of 1959. The Consultative Committee of E.C.S.C. has voted in favour of an extension of the special aid to Belgian miners until September.

British Weather Radar for Swiss Airports

Two international Swiss airports, Geneva (Cointrin) and Zürich (Kloten), will be equipped with British-made Decca weather radar. In both cases the installation will be on high ground some distance from the airfields, with radar links to relay the radar information to the airfield meteorological offices. At Geneva the installation will be on La Dole, a high peak in the Jura mountains, some 20km from the airport, and at Zürich the Albis, a peak 12km from the airport, will be used.

The equipment will be installed by Radio-Suisse S.A., Berne, who are acting on behalf of the Swiss Federal Air Office. These will be the sixtieth and sixty-first installations of Decca weather radar ; more than 75 per cent of these weather radar installations are being used directly for aviation forecasting.

Federation Européenne de la Manutention

A meeting of the European Federation of Materials Handling, Section IV (Industrial Trucks) was held in Paris on May 21 and 22. It was decided to extend the four F.E.M. stability tests for fork lift trucks, with minor modifications, to trucks of between 10,000 lb and 20,000 lb capacity. Discussions took place on standardisation of tyres, both pneumatic and cushion, which should be included in the eventual lists of recommended sizes. Substantial progress was made in relation to standardisation of controls. It was agreed to produce the proposed Safety Code in two parts, the first being a Manufacturers' Code of Practice, the second part being a simplified code for circulation among users, comprising nomenclature, stability factors, brake performance, &c., as well as sections devoted to operating techniques and maintenance. Among other matters discussed was the standardisation of fork carriages for fork lift trucks where the American practice is likely to be adopted.

European Federation of Purchasing

At a meeting in Düsseldorf on October 18, 1958, a European Federation of Purchasing (Fédération Européenne de l'Approvisionnement) was formed. The founder-members of the Federation are : Bundesarbeitsgemeinschaft Industrieller Einkauf (Germany), Compagnie des Chefs d'Approvisionnement (France), Nederlandse Vereniging Voor Inkoop-Efficiency (Holland), Purchasing Officers Association (United Kingdom), Svenska Inköpsledares Foregning (Sweden). Pending the first election of officers, the Acting Secretary is Mr. J. R. Blinch, the Secretary of the Purchasing Officers Association, Wardrobe Court, 146a, Queen Victoria Street, London, E.C.4. A European Purchasing Conference took place in Brussels in May, 1958. The second of these Conferences will be held in Scheveningen, from April 20 to 23, 1960.

Personal and Business

Appointments

MR. E. H. CURTIS has been appointed general manager of Carbide Industries, Ltd.

MR. JOHN K. WILLIAMSON, secretary of W. P. Butterfield, Ltd., has been appointed a director.

MR. WILLIAM FRASER has been appointed a director of British Insulated Callender's Cables Company, Ltd.

VAC-U-LIFT (GREAT BRITAIN), Ltd., announces that Mr. E. R. Johnson has been appointed design engineer.

MR. LAWRENCE ARTHUR CORNEY, A.M.I.E.E., has been appointed chief safety officer of The Electricity Council.

MR. WINSTON BRIMACOMBE has been appointed to be a part-time member of the South Western Electricity Board.

PELAPONE ENGINES, Ltd., has announced the appointment of Mr. R. W. Storey to the position of managing director.

THE MINISTRY OF SUPPLY has announced that Captain E. C. Beard, R.N., has been appointed director of Royal Naval Aircraft Research and Development.

THE VISCOUNT KNOLLYS, chairman of Vickers, Ltd., has been elected chairman of English Steel Corporation, Ltd., in succession to the late Sir Frederick Pickworth.

SHEEPBRIDGE STOKES, Ltd., has announced the appointment of Mr. Michael E. Southway as a new technical representative in the south-west England and South Wales areas.

ADVANCE MOTOR SUPPLIES, Ltd., announces that Mr. L. U. Garroch has been appointed manager of its branch at 374/376, Argyle Street, Glasgow, (telephone, City 6178/9).

MR. P. L. LOWRIE, A.M.I.E.E., and Mr. W. H. D. Campbell have been appointed directors of the British Geco Engineering Company, Ltd., induction heating division, Edenbridge, Kent.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY announces the appointment of Air Chief Marshal Sir Claude Bernard Raymond Pelly as member (Designate) for weapons. He will take up the appointment later this year.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces that Captain E. C. Miles has been appointed a member of the council of the Air Registration Board, in place of Captain T. H. Farnsworth, those term of service as pilot representative has expired.

THE PRODUCTION ENGINEERING RESEARCH COUNCIL has announced that Sir Basil R. G. Tangye, M.I.Mech.E., has been elected chairman of the Council, in succession to Sir Lionel Kearns. Sir William Stanier, F.R.S., has been re-elected president of the Association.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., announces that Mr. E. A. Bingen has been elected a deputy chairman, and that it has agreed to elect Mr. L. H. Williams as a deputy chairman with effect from March 1, 1960, when Mr. S. P. Chambers will succeed Sir Alexander Fleck as chairman.

RUSTON AND HORNSBY, Ltd., announces that Mr. Geoffrey W. Bone, M.I.Mech.E., a director, has assumed responsibility for the company's engineering policy and for that of its associate, Davey, Paxman and Co., Ltd. Mr. J. R. Bergne has been appointed an assistant managing director of Ruston and Hornsby, Ltd.

LIEUT-COMMANDER J. W. THORNYCROFT, in September last year, was elected deputy chairman of John I. Thornycroft and Co., Ltd., and on July 31, 1959, he relinquished the post of managing director of Transport Equipment (Thornycroft), Ltd. He will continue as chairman and a director of Transport Equipment (Thornycroft), Ltd. Mr. R. F. Newman, M.I.P.E., has succeeded him as managing director of Transport Equipment (Thornycroft), Ltd., and has been elected a director of John I. Thornycroft and Co., Ltd. Engineer Captain G. Villar and Mr. L. L. Holt have retired from their executive positions as general manager and commercial manager of the Southampton Works, and also from the board of John I. Thornycroft and Co., Ltd. Mr. Ian Cameron has been appointed general manager, and Mr. F. B. Crabtree commercial manager, of the company's Southampton works.

Business Announcements

G. AND J. WEIR HOLDINGS, Ltd., announces that it has arranged to acquire the whole of the issued share capital of Lobnitz and Co., Ltd.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces the retirement of Mr. W. G. Hendrey, M.I.E.E., who has been a director since 1938.

DUNLOP RUBBER COMPANY, Ltd., 10–12, King Street, St. James's, London, S.W.1, announces that a new tyre factory has been opened in Bulawayo.

MR. ARTHUR HILLIER, chairman and managing director of Sperry Gyroscope Company, Ltd., has retired after forty-three years' service with the company.

BALDWIN INSTRUMENT COMPANY states that its name has been changed to Baldwin Industrial Controls, and that it has moved to larger premises in the centre of Dartford.

POWELL DUFFRYN, Ltd., has announced that its subsidiary, Cambrian Wagon and Engineering Company, Ltd., has changed its name to Powell Duffryn Engineering Company, Ltd.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., and Engelhard Industries, Inc., New Jersey, U.S.A., have signed agreements covering the sale and production of platinum-titanium electrodes.

DECCA RADAR, Ltd., Albert Embankment, London, S.E.11, announces that it has purchased the lease of Cowes Airport and will be establishing a manufacturing unit there in the near future.

WEST INSTRUMENT, Ltd., has opened a Scottish office at 27, Rutland Square, Edinburgh, for sales and service of temperature control equipment. Mr. Ian White has been appointed manager of this office.

THE ROYAL AERONAUTICAL SOCIETY announces that its prize in aeronautics has been awarded this year to Mr. James Brian Hargrave, as the best student of his year in the diploma course at the College of Aeronautics.

CLAUDE LYONS, Ltd., Valley Works, Ware Road, Hoddesdon, Herts, states that its Liverpool and Hoddesdon offices have now been connected to the telex service. The numbers are Liverpool 62181 and Hoddesdon 22724.

THE BRITISH OXYGEN GROUP OF COMPANIES announces that all its specialised services to aviation are now being co-ordinated through British Oxygen Aviation Services, Bridgewater House, St. James's, London, S.W.1.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., announces that its Plastics Division is to erect a new plant near Dumfries for the manufacture of "Melinex" polyester film. The plant will eventually have a capacity of 2000 tons or more a year.

THE BOWATER PAPER CORPORATION, Ltd., Bowater House, Knightsbridge, London, S.W.1, has acquired the whole of the share capital of Flexpipe, Ltd., which is to produce pitch fibre pipes in a factory to be erected at Ellesmere Port.

J. H. FENNER AND CO., Ltd., has announced the formation of Fenner Woodroffe and Co., Private Ltd., in Madras, in association with Gordon Woodroffe and Co. The new company will manufacture leather power transmission belting.

BRITISH INDUSTRIAL GASES, Ltd., 700, Great Cambridge Road, Enfield, Middlesex, has concluded an agreement with the Harris Calorific Company of Ohio, U.S.A., whereby the American designs in oxy-fuel gas cutting equipment will be manufactured in Great Britain.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., 33, Grosvenor Place, London, S.W.1, states that a central information department is being established under the joint management of Mr. H. H. Lusty and Mr. R. H. Veysey, who will be concerned respectively with advertising, and press and public relations.

THE AMERICAN MACHINE AND FOUNDRY CORPORATION of the United States and WILLIAM BOBY AND CO., Ltd., of Rickmansworth, have signed a sales agreement for the American firm to market Boby electrodialysis stacks in the United States, Canada, and elsewhere in the Western Hemisphere excluding British territories.

G. AND J. WEIR, Ltd., Cathcart, Glasgow, and Chicago Bridge and Iron Company, Chicago, Ill. announce that they are setting up a jointly-owned subsidiary company in the United States, to be known as Weir-Chicago Bridge, Inc. The new company will have as its objective the design, fabrication and erection of saline water conversion plants.

Contracts

JOHN HOWARD AND CO., Ltd., has been awarded a contract by the City and County of Bristol for the foul water drainage scheme. The contract comprises the construction of the outfall to the Severn Estuary at Holes Mouth, the construction of a 7ft 6in high by 10ft 6in wide reinforced concrete effluent culvert, a triple 6ft diameter concrete pressure pipe pumping main, valve chambers and culverts, road works, piled foundations and ancillary works. The value of the contract is in excess of £600,000. Work will start immediately and the contract will be completed in the autumn of 1961.

THE CENTRAL ELECTRICITY GENERATING BOARD has placed contracts during the past month for power stations, transmission lines and transforming stations, totalling about £20,570,000. The main contracts include: Bankside "B" power station, condensing and feed heating plant for No. 3 turbo-generator (Worthington-Simpson, Ltd.); West Thurrock power station, superstructures for administrative block and workshop, turbine house, annexes and auxiliary buildings (Richard Costain, Ltd.); Rugeley power station, five 120MW reheat boilers (Babcock and Wilcox, Ltd.); Thorpe Marsh power station, structural steelwork for turbine house and boiler house (Redpath Brown and Co., Ltd.), and one 550MW reheat boiler (International Combustion, Ltd.); Lydd substation, two valve-supply transformers, 85/102/55MVA, 275/90/33kV (Fuller Electric, Ltd.); Hart Moor substation, 275kV switchgear (Ferguson Pailin, Ltd.); Windscale-Egremont and Windscale A.G.R. substation, 132kV overhead lines (Pirelli-General Cable Works, Ltd.).

Miscellanea

MR. JOHN BAIRD.—We have learned with regret of the death of Mr. John Baird, B.Sc., which occurred on August 2. Mr. Baird, who was born in 1896, was chief naval architect to The New Zealand Shipping Company, Ltd., and the Federal Steam Navigation Company, Ltd., from 1938 to 1958, during which period some thirty-five ships were built under his supervision. Since 1958 he has been acting as consulting naval architect to the two companies.

SCREWED RIVET BUSHES.—A series of screwed rivet bushes for sheet metal made by the Benton Engineering Company, Ltd., Tonbridge Road, Harold Hill, Essex, is available with thread sizes from $\frac{1}{4}$in to $\frac{1}{2}$in for up to 16 gauge sheet; $\frac{5}{8}$in for 14 gauge sheet; $\frac{3}{4}$in and $\frac{7}{16}$in for 12 gauge sheet; and $\frac{1}{2}$in for 11 gauge sheet. The bushes are machined with a thin annular wall projecting from their upper faces and the shoulder formed below the wall is recessed inwards and serrated. To fit a bush the sheet metal is drilled with a push-fit hole for the wall. A sharp blow on the inside of the wall then bends it over into close frictional contact with the sheet and at the same time the serrated face of the bush shoulder penetrates the metal to lock the bush securely in position.

RESONANCE HEATING IN TUBES.—The July, 1959, issue of the *Journal of the Aero/Space Sciences* contains a note by J. Wilson and E. L. Resler, Jnr., proposing "A Mechanism of Resonance Tubes." This proceeds from the observation that the photographs obtained by Hall and Berry at the N.P.L. (see page 748, May 8, 1959) show the disturbance growing narrower as it proceeds, suggesting that it is a steepening pressure wave. The basis of this theory is that resonance occurs when the position of the shock wave in front of the tube is unstable. The emergence of a shock from the tube will move the standing shock upstream away from the tube, thus decreasing the pressure at the mouth of the tube and propagating an expansion wave into the tube. When the reflected expansion wave returns out of the tube, the shock wave moves downstream towards it: thus there is created a pressure wave which, because of the movement of the source, is considerably narrower than the expansion wave. This narrowness is increased by the classical steepening of pressure waves, until at some point in its progress the wave steepens to a shock. The theory is developed to show that, if there are no heat losses from the tube, the degradation of energy in the shock raises the temperature until the wave steepens to a shock only as the wave leaves the tube: if there are losses from the tube, a shock must form within the tube to supply the heat, and the steady state temperature will be lower. This theory may explain the appearance that the jet penetrated the tube while the wave was moving outward, since at this part of the cycle the "standing" shock has moved toward the tube. The low velocity of propagation suggested by the photographs is not discussed.

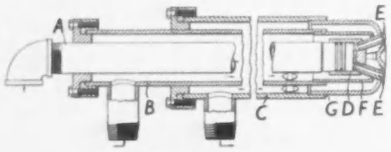
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

FURNACES

812,840. January 28, 1957.—GAS-DISCHARGE NOZZLE FOR FURNACES, United States Steel Corporation, 525, William Penn Place, Pittsburgh 30, State of Pennsylvania, United States of America.

The use of oxygen in the open-hearth furnace presents a serious problem in respect to the nozzle of the supply tube or lance because it must be lowered to within a short distance of the charge and is subjected for substantial periods of time to extremely high-temperature conditions, e.g., 6000 deg. Fah. A large constant flow of water must be maintained particularly at the extreme end of the nozzle, to provide adequate cooling. The gas-jet nozzle described is adapted for oxygen lances with provisions for insuring adequate cooling without leakage of water and permitting ready replacement. Referring to the drawing, an oxygen-supply pipe *A* is



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connected by a flexible hose to a source of gas. An inner tube or baffle tube *B* surrounds and is spaced from pipe *A*. An outer tube forming a water chamber *C* surrounds the baffle tube. A nozzle head in the form of a dome with a rounded end is brazed in the end of chamber *C* at *G*. A cup-shaped hub *D* is a sliding fit on the end of tube *A*. The end wall is drilled and tapped to receive jet tubes *E* extending through holes in the end shell. A sleeve *F* fits snugly in the end of baffle tube *B* and is notched to fit loosely about tubes *E*, and be loosely confined between baffle and head. By virtue of this construction oxygen flowing through tube *A* divides into diverging jets on passing through tubes *E*. Cooling water flows through the space between tubes *A* and *B*, then through sleeve *F* between its flange and the inner end and around the tubes close to their exposed ends. Adequate and effective cooling is assured by the rapid flow and intimate contact produced, and the nozzle may be easily removed as a unit from the lance formed by tube *A* and chamber *B* by turning off joint *G*. A replacement nozzle may then be slipped in place and brazed. Modified nozzle designs are also described in the specification.—*May* 6, 1959.

METALLURGY

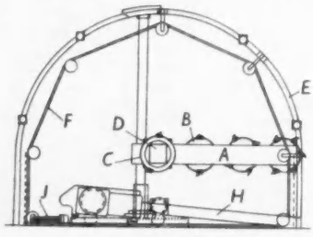
812,848. May 16, 1957.—HIGH-DENSITY SINTERED METAL COMPOSITIONS OR ALLOYS, Mallory Metallurgical Products, Ltd., 78, Hatton Garden, London, E.C.1.

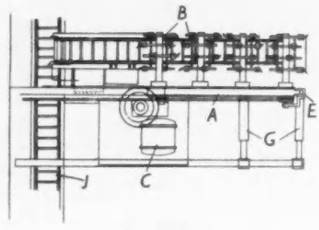
This invention relates to improvements in and relating to high-density pressed and sintered metal compositions or alloys, and, more particularly, to compositions or alloys containing a predominant proportion of tungsten. Heretofore, tungsten base alloys, especially a group of these alloys in which small percentages of nickel and copper were alloyed with the tungsten base, have been used commercially on a substantial scale for applications where their high density and other physical characteristics have been found to be desirable. Although these prior tungsten-nickel-copper alloys possessed valuable properties in addition to their high densities the principal object of the invention is to provide improved high-density tungsten base alloys characterised by tensile strengths greatly exceeding those obtainable with conventional alloys. The applicants have discovered that high-density alloys of heretofore unobtainable strength and other characteristics may be obtained by alloying tungsten with specified proportions of copper, nickel and molybdenum, or of copper, nickel, molybdenum and iron. The alloys within the contemplation of the invention contain at least 65 per cent by weight of tungsten and various amounts of nickel, copper, molybdenum and iron in controlled and correlated proportions. The function of the additions is to form a strong alloy matrix surrounding the tungsten or tungsten and molybdenum grains, imparting to the alloy as a whole under controlled conditions ultimate tensile strengths much greater than those of the conventional high-density tungsten alloys to as high as that of well annealed pure tungsten. It has been found that with specific powder characteristics and under controlled sintering conditions the mechanical properties of the sintered alloys of the invention may be varied within wide limits; thus, ultimate tensile strengths from 100,000 lb per square inch to greater than 160,000 lb per square inch, and ductilities from a fraction of 1 per cent to greater than 9 per cent in 1in may be readily obtained.—*May* 6, 1959.

MINING MACHINERY

813,706. July 26, 1957.—MINING MACHINES, Coal Industry (Patents), Ltd., Hobart House, Grosvenor Place, London, S.W.1. (*Inventor: Cecil Vowe Peake.*)

A mining machine for ripping the face at a road head in coal mines is shown in the drawing. It comprises an arm *A* on which are mounted to one side, drums *B* carrying cutter picks, the drums being of such a size and so spaced that their plan area is completely covered by picks during the rotation of the drums, to ensure that the mineral being cut is crushed to a small size, and no large pieces are brought down. The arm contains the gearing necessary to rotate the drums and is of such strength





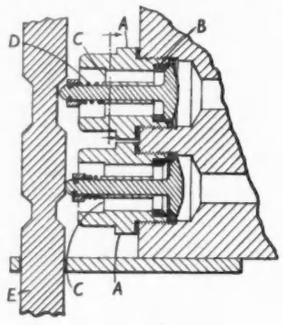
No. 813,706

that it can take all the cutting forces. A main motor *C* on the arm drives the drums through the gearing. The arm can be swung in the vertical plane around a fulcrum *D*, the height of which is determined by the size of the road required. The fulcrum can be raised and lowered by a hydraulic jack (or ropes) up a vertical pillar which comprises a hydraulic jack between the roof and floor. The outer end of the arm is guided in a frame *E* the same shape as the roadway. The arm is rotated around its arc of cut by a rope *F*. The frame is mounted on mechanical or hydraulic pushing jacks *G* fixed to the last erected permanent road support. To collect and remove the cuttings there is laid across the bottom of the road a small chain or other type of conveyor *H*, which delivers the cuttings to another conveyor *J* running along the road, either towards the face or to a stowing machine located to pass the cuttings into the roadside packs.—*May* 21, 1959.

PUMPS

813,502. December 28, 1955.—INLET VALVES FOR PUMPS, W. H. Marley and Co., Ltd., 105, High Road, New Southgate, London, N.11; Norton Tool Company, Ltd., and Douglas Edwin Norton, Plough Road, Smallfield, Horley, Surrey.

In the arrangement described, a pump for supplying pressure fluid to a high pressure hydraulic press tool has several cylinders, each provided with an inlet valve according to the invention. The drawing shows in cross-section a pair of pump inlet valves, the upper one of which is closed and free for normal operation while the lower is held open to off-load the cylinder. Each valve in a side-entry in the pump body comprises a fixed guiding valve body *A* with a reduced portion threaded in the entry. A movable poppet valve head seats against a frusto-conical face of a seating ring *B* which projects part of the way across each port. Each fixed valve body has a number of longitudinal bores *C*, the inner ends of which are closed when the valve head is seated. Around each valve stem is a light coil spring *D* which urges the valve towards the closed position. Normally, each valve opens and closes automatically as the pump operates, but means are provided for holding one or both of the valves open continuously against the spring action and thereby off-loading the pump cylinder associated therewith. This means consists of a cam bar *E* which can be slid endwise past the external end of a valve stem and unseat it, as shown in the case of the lower



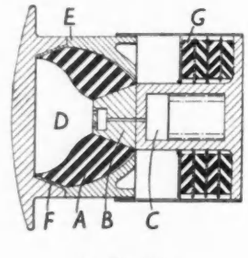
No. 813,502

valve, when it is desired to put the pump cylinder out of operation. By this means, a multi-cylinder pump may have one, two or more cylinders actually delivering pressure fluid to the press ram. Other arrangements for holding the valves in the open position, for example using rocker cams, may be employed if desired. The head of each valve is appreciably lighter than valves of this kind usually are, so as to reduce inertia effects retarding valve operation.—*May* 21, 1959.

RAILWAYS

813,578. March 21, 1957.—BUFFERS FOR RAILWAY AND LIKE VEHICLES, George Spencer Moulton and Co., Ltd., Manvers House, Bradford-on-Avon, Wiltshire, formerly of 13 and 14, Ashley Place, Westminster, London, S.W.1. (*Inventor: Alexander Eric Moulton.*)

Heretofore outside buffers have included a buffer guide carried by the headstock of the vehicle and mounting a head co-operating with springs; the invention provides a buffer in which the necessity for guide means and their lubrication is avoided. Two embodiments are described with reference to drawings, one of which we reproduce. The main



No. 813,578

buffer spring *A* is bonded to a hollow spigot *B* which contains a reservoir *C* for hydraulic fluid in the space *D*. The rubber spring *A* projects forward to mount a shell *E* which is a complementary fit in the buffer structure and carries the buffer head. Rubber spring *A* is bonded to shell *E* at *F*. The interior wall of the rubber spring acts as a flexible container for the hydraulic medium and this container communicates with the reservoir *C* through suitable control valves situated in the front end of the spigot. Inward movement of the buffer is resisted not only by deformation of the rubber spring but also by that of the fluid which has to pass into the reservoir through the control valve. A second stage rubber spring shown comprises a column of rubber springs *G* with separating plates encircling the spigot *B* and co-operating with a flared skirt in the rear of the buffer head. This column of rubber rings is compressed by further inward travel of the buffer after a predetermined initial movement.—*May* 21, 1959.

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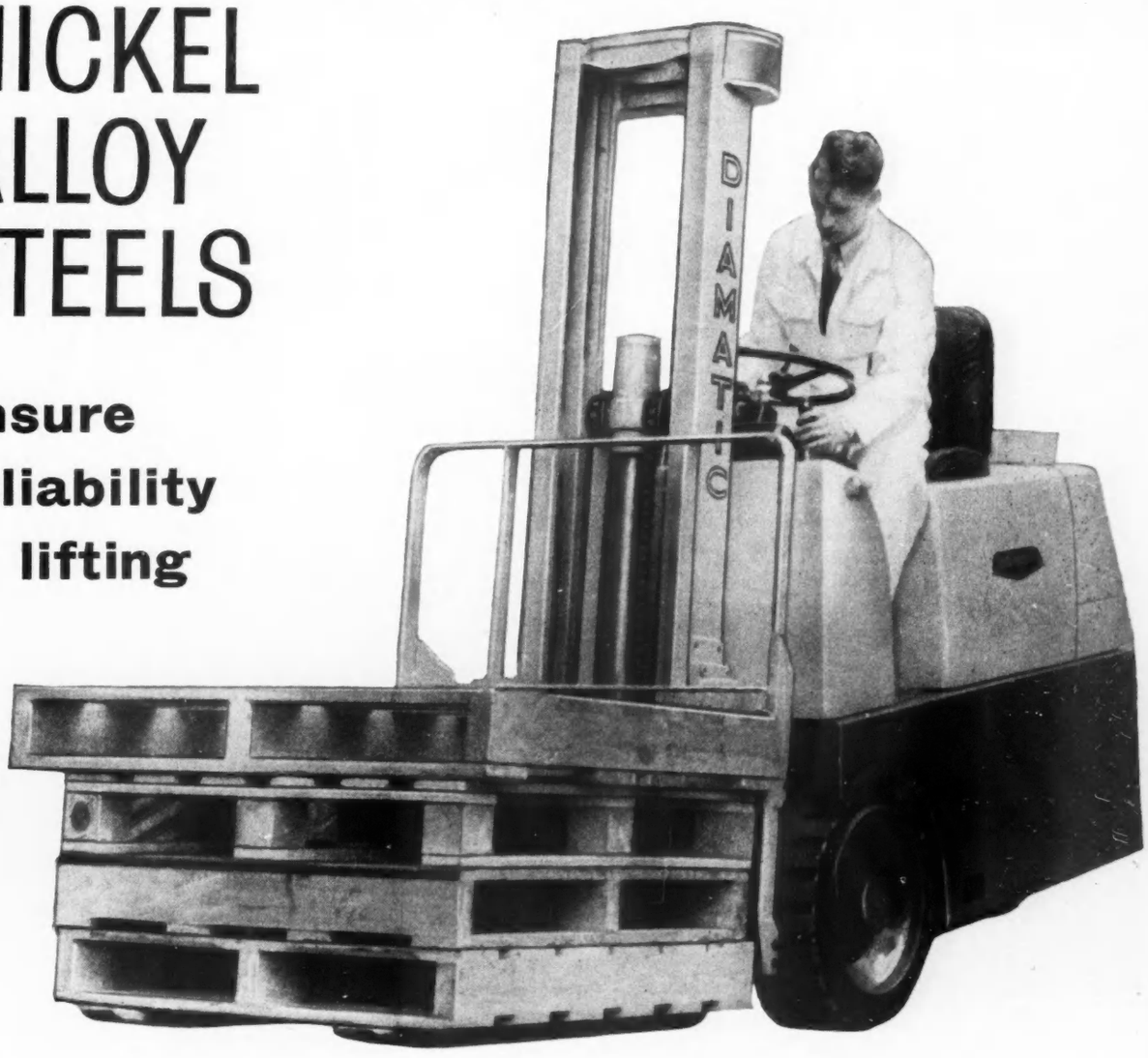

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The benefits to be gained from the more highly alloyed case-hardening nickel steels, such as EN 33, EN 34, EN 36 and EN 39 include ease of heat-treatment, minimisation of processing distortion, and general reliability.

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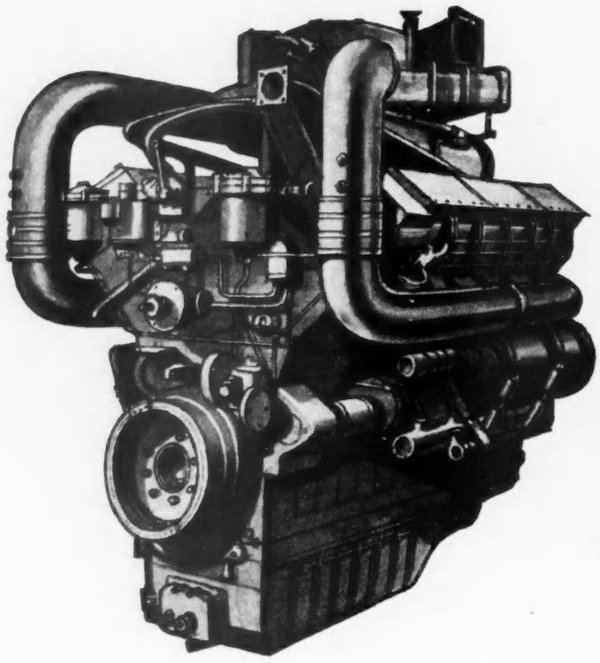
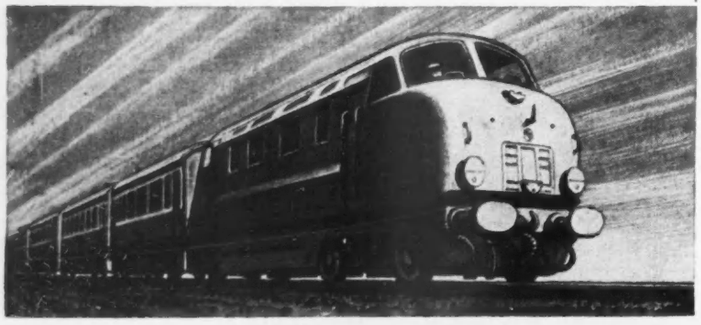


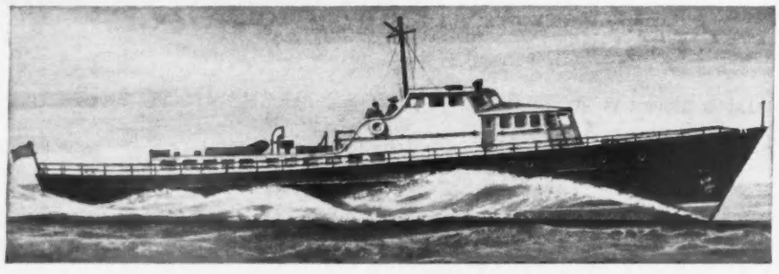
Typical of the MD range of engines is this Type 650 12 cylinder supercharged model with cylinders arranged in 'V' formation.



Railway Traction 220-2,000 B.H.P.

Industrial Plant 220-1,750 B.H.P.

Marine 220-3,000 B.H.P.



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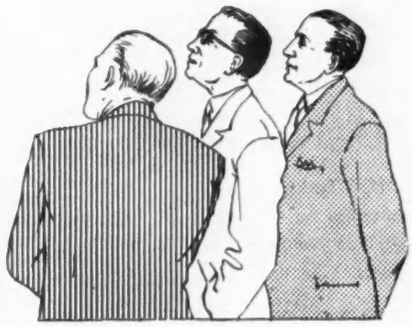

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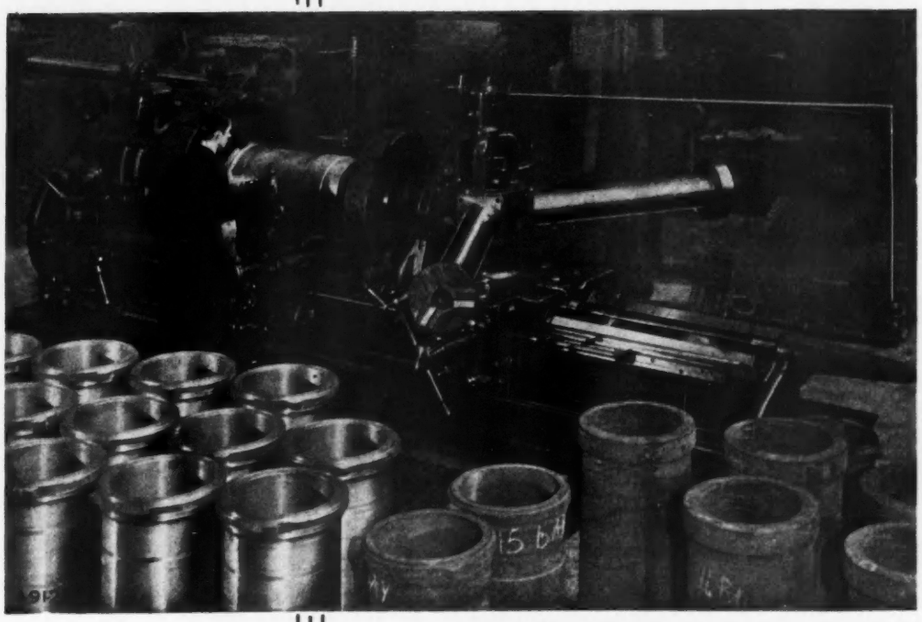

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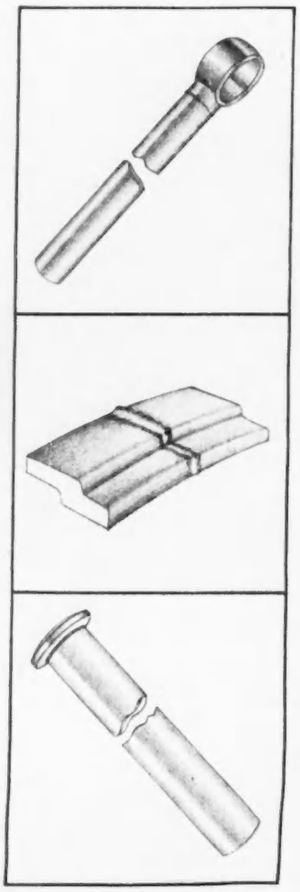

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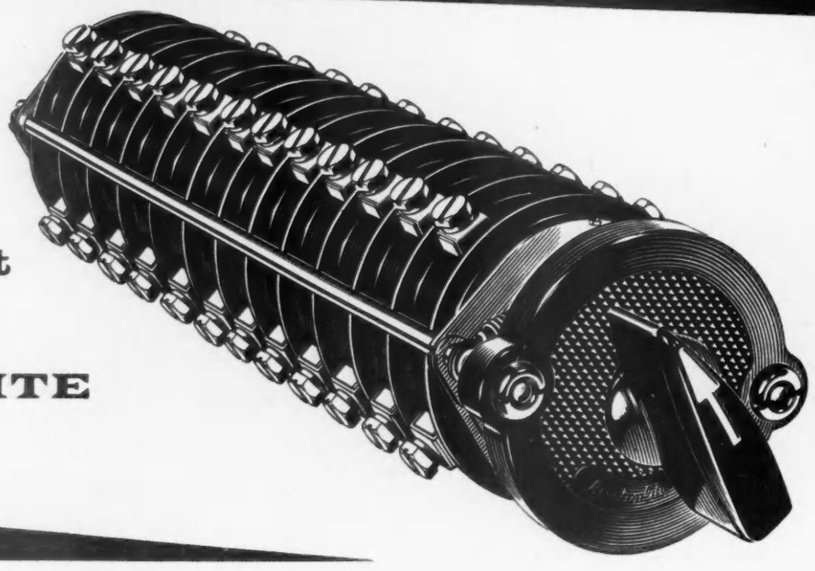

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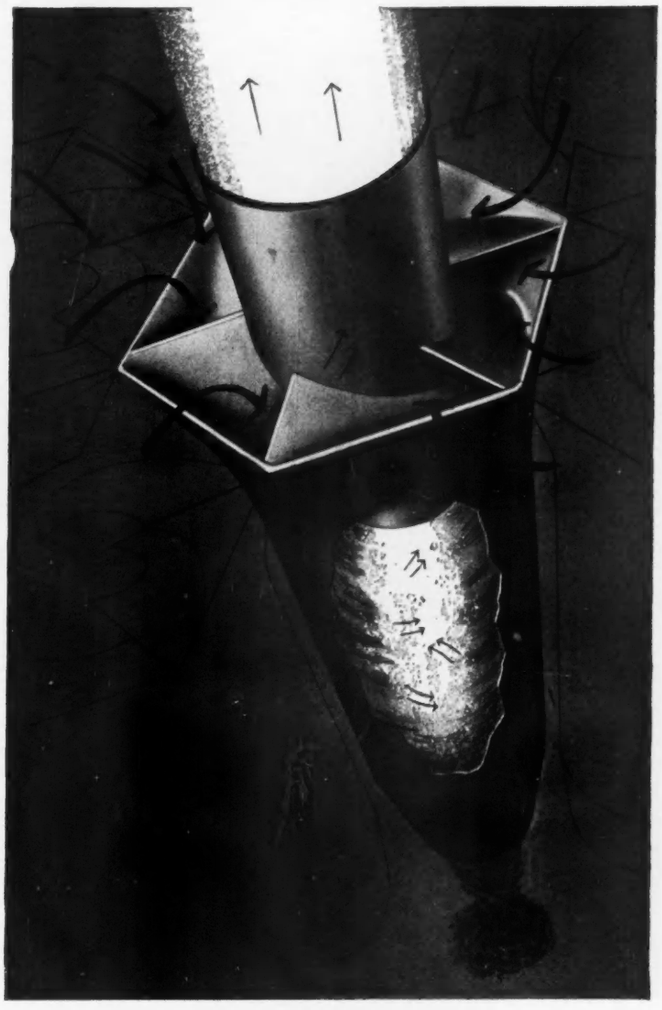

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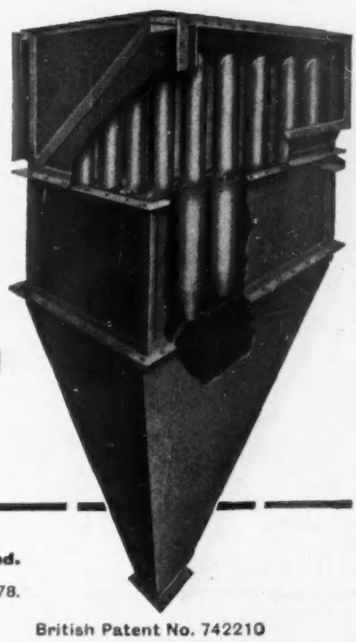

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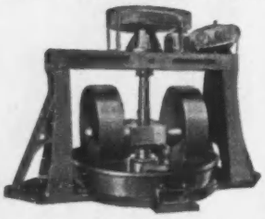

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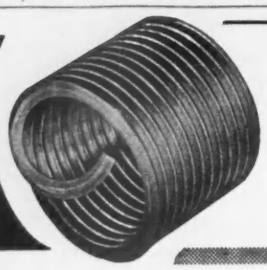

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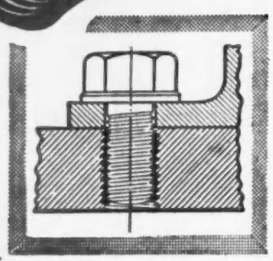

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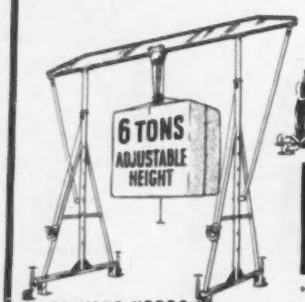

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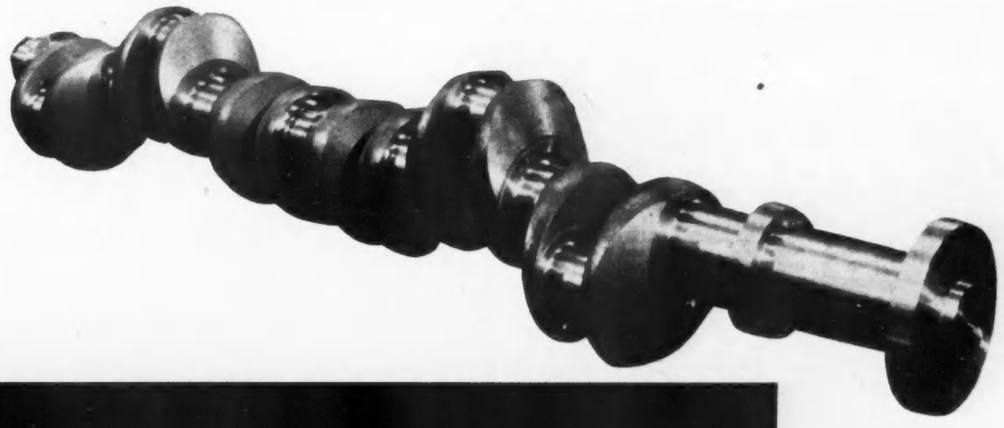

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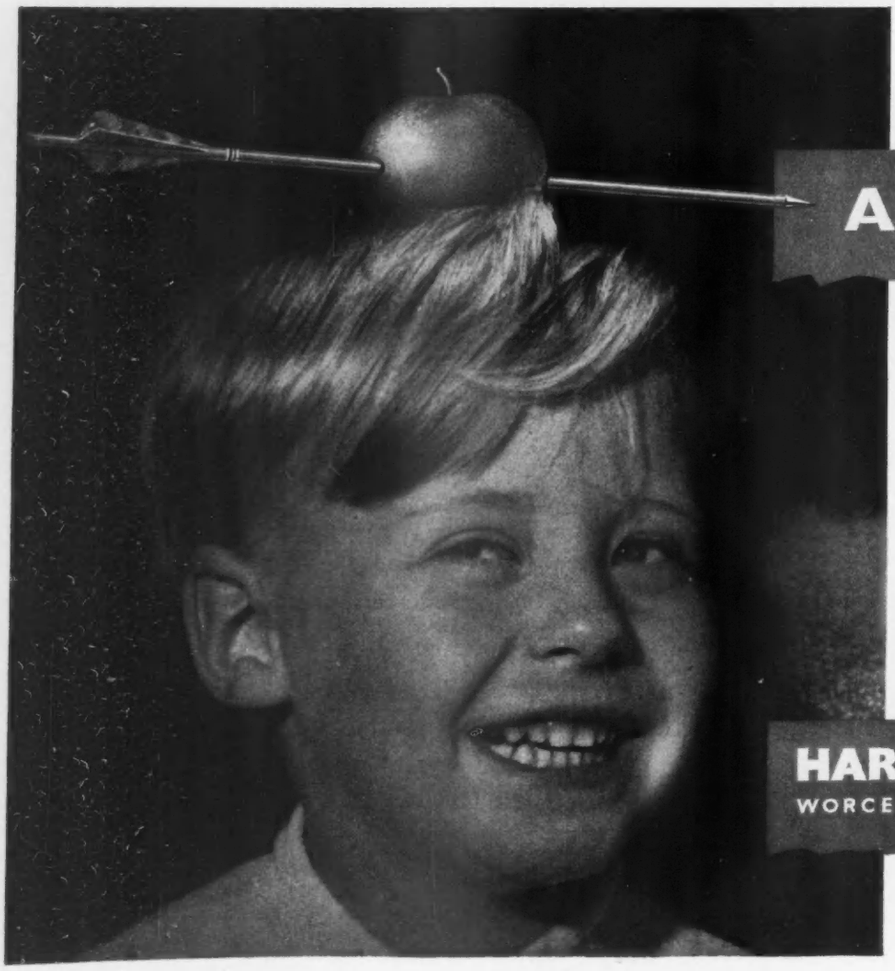

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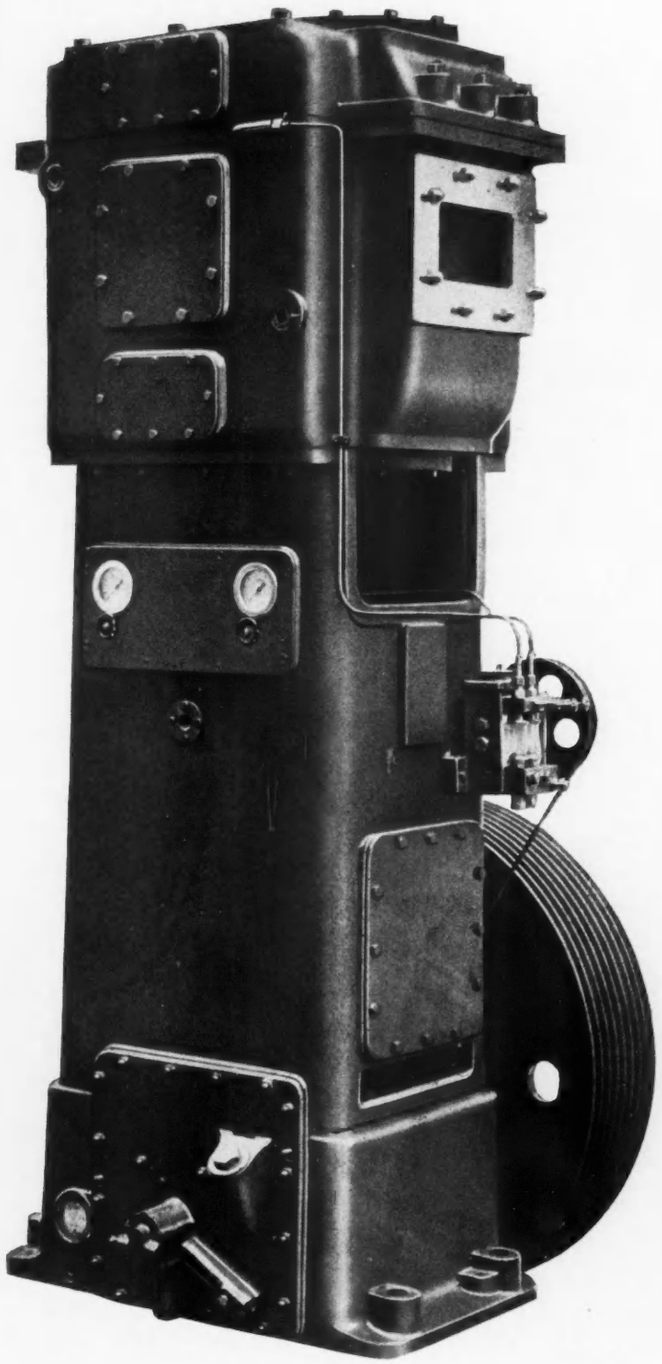

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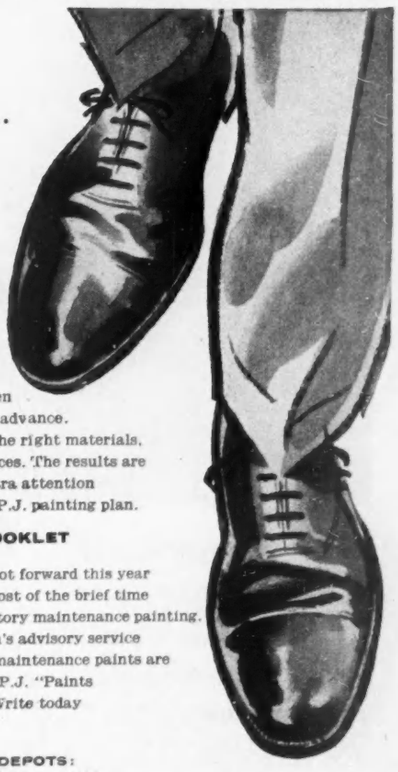

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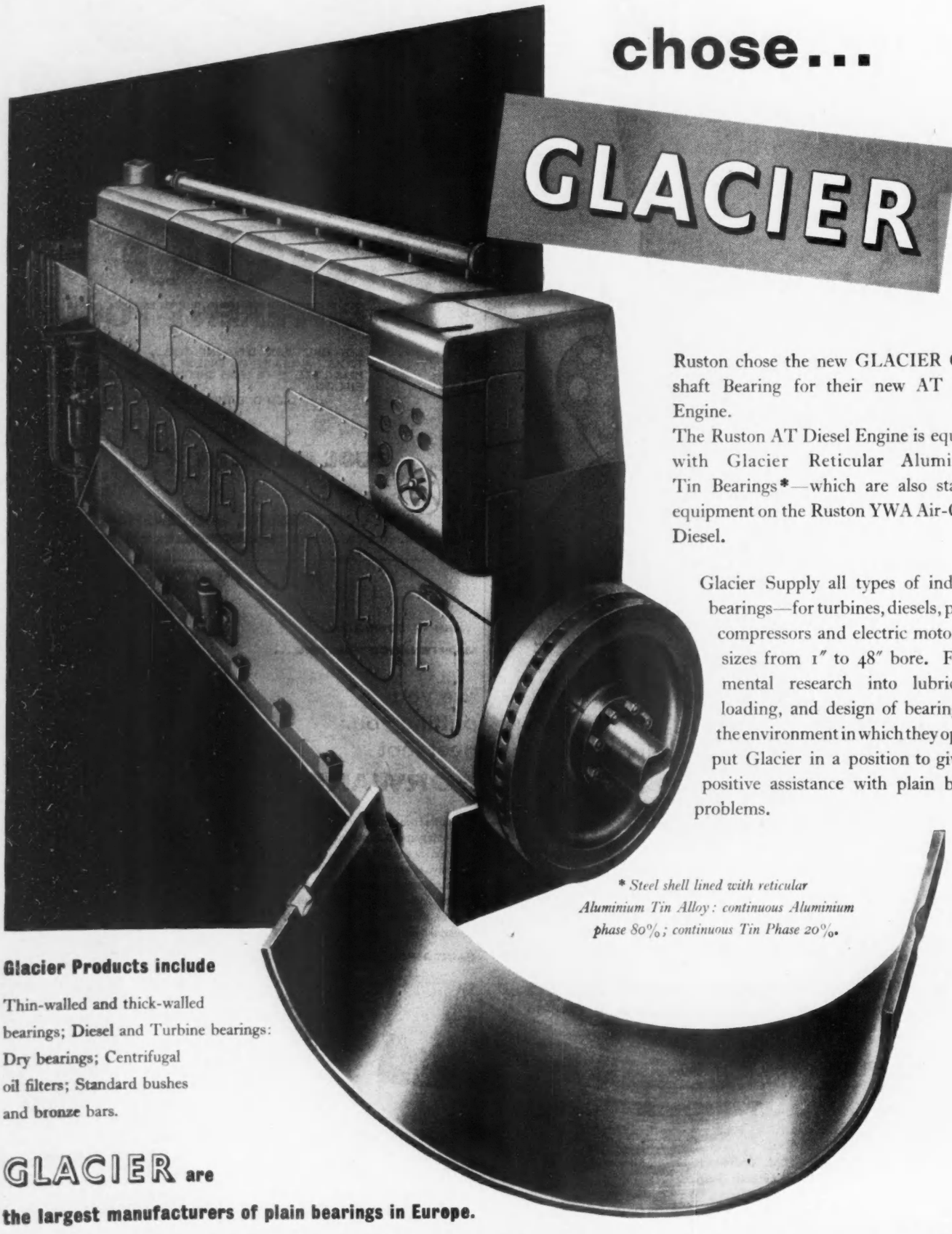

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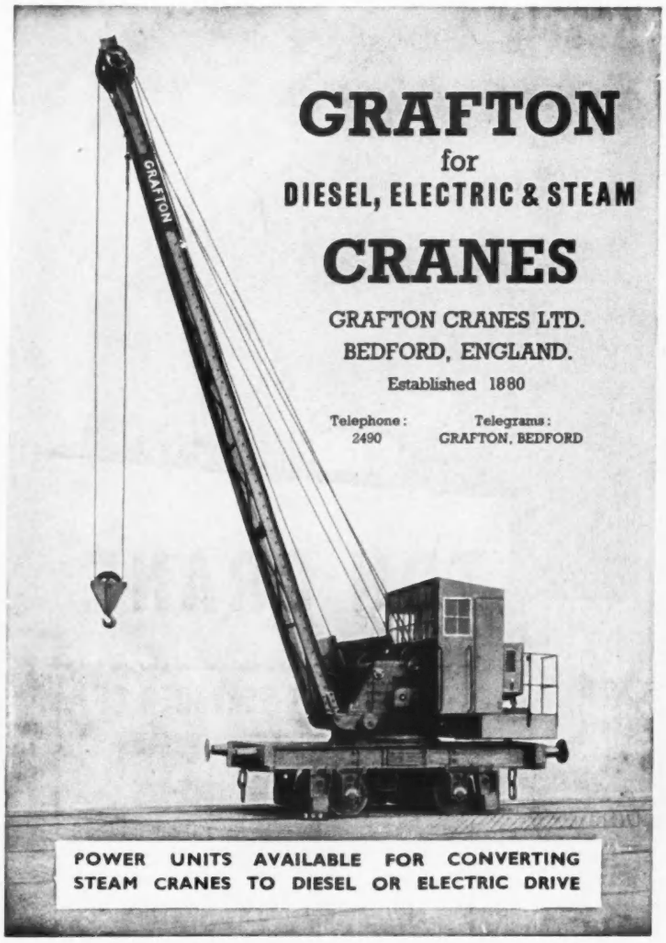

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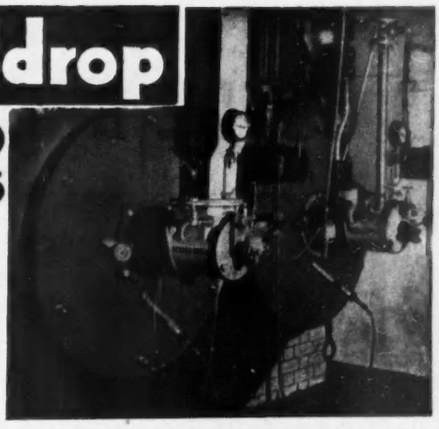

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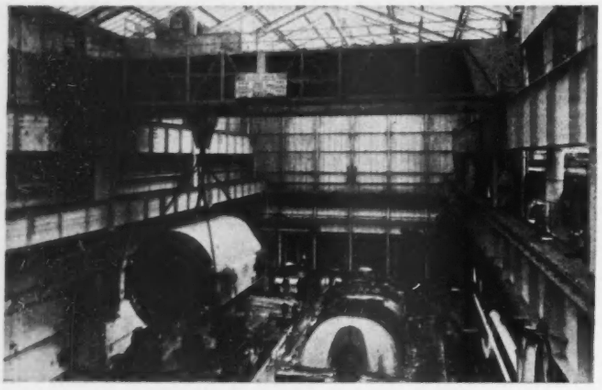

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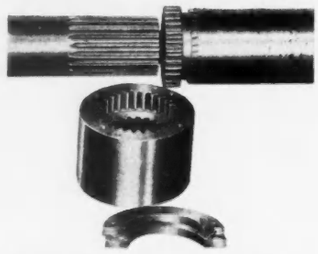

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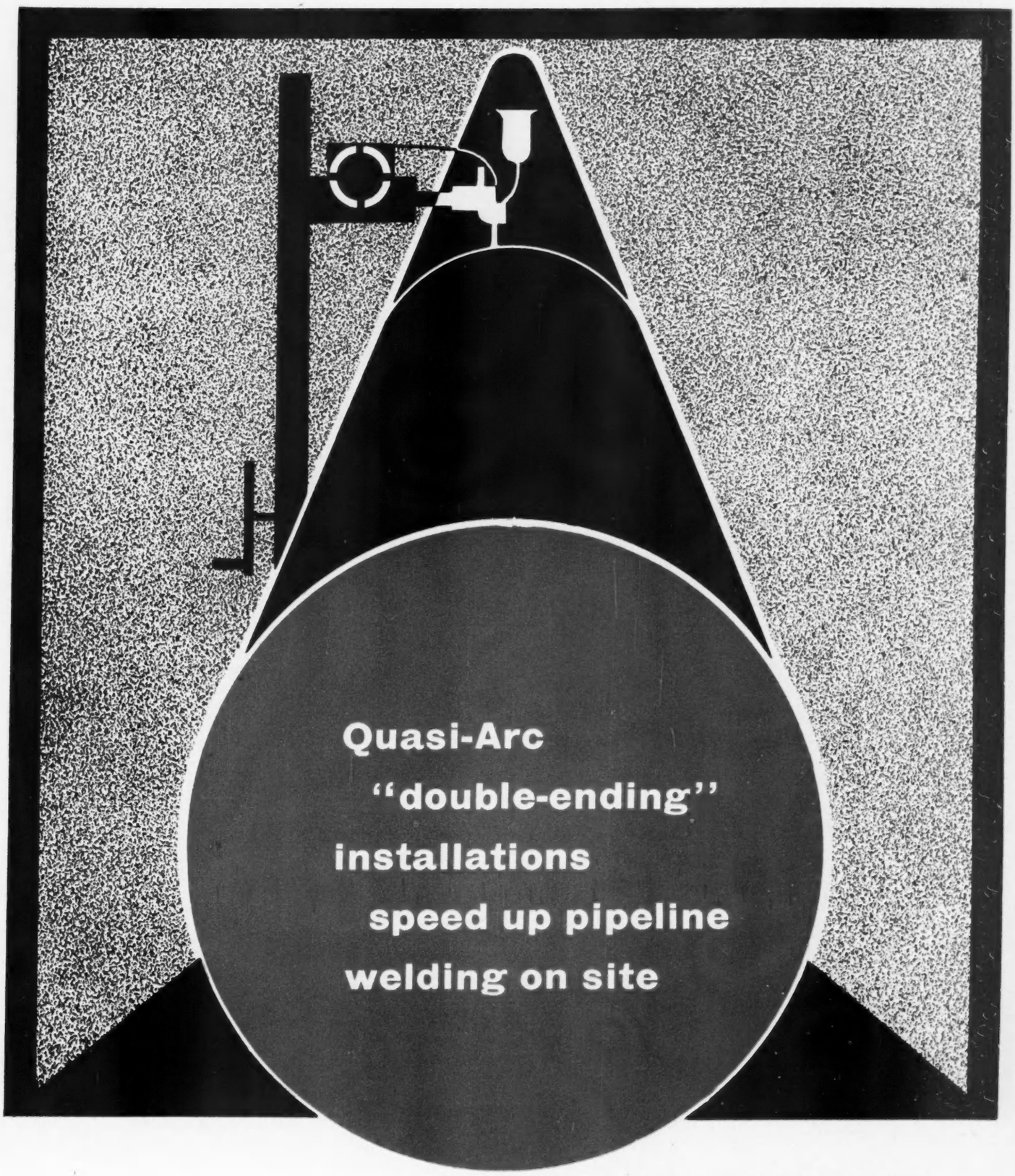

The Quasi-Arc "Double-Ending" Machine (or "Double-Lengthening" or "Double-Jointing" if you prefer) uses the UNIONMELT or FUSARC/CO_2 processes to weld two lengths of pipe together, automatically on the site, before laying. Thus the number of joints that have to be welded manually is halved, and a considerable saving in time achieved.

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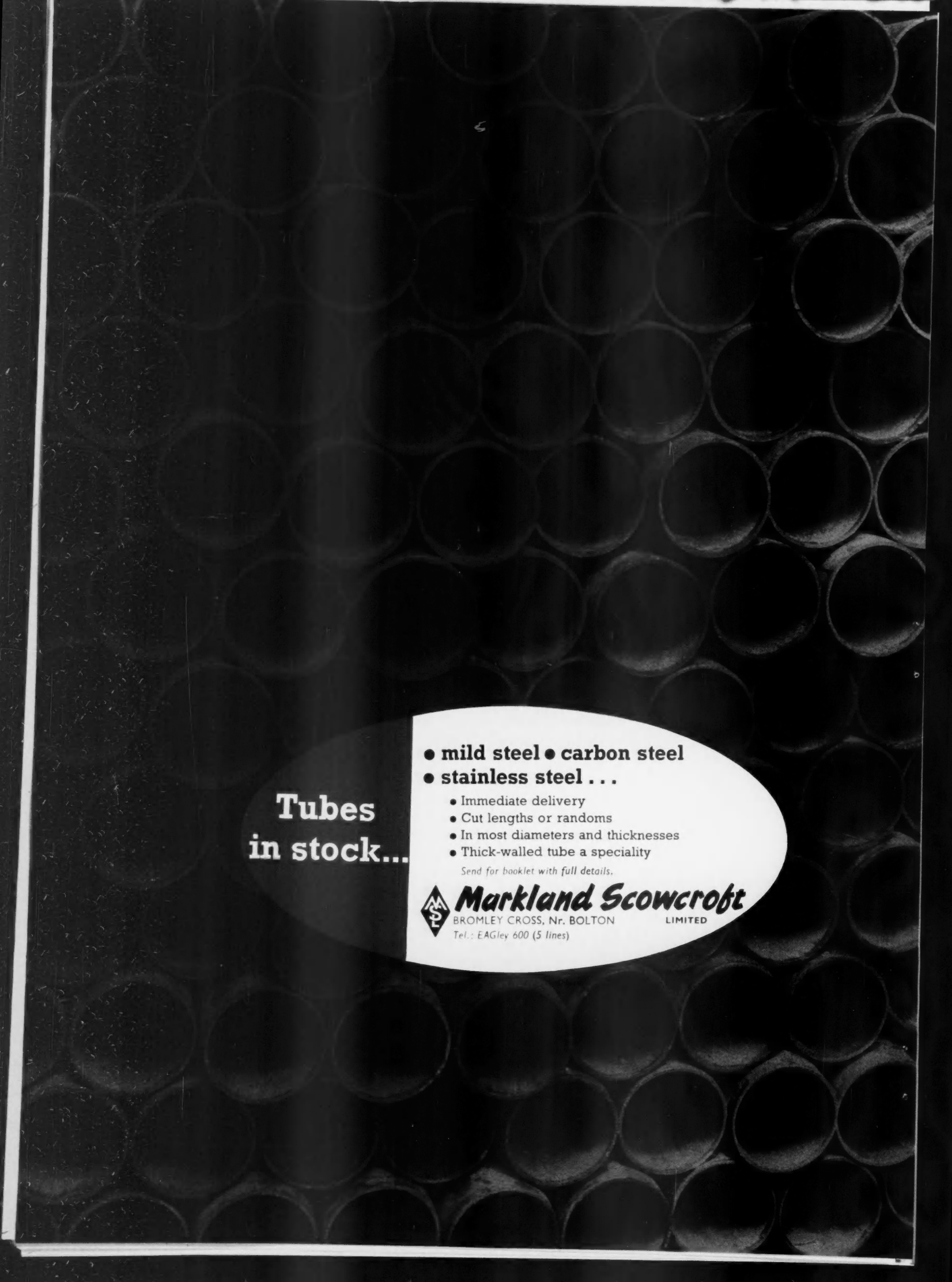
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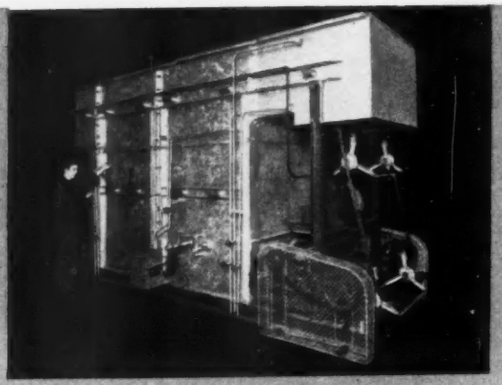
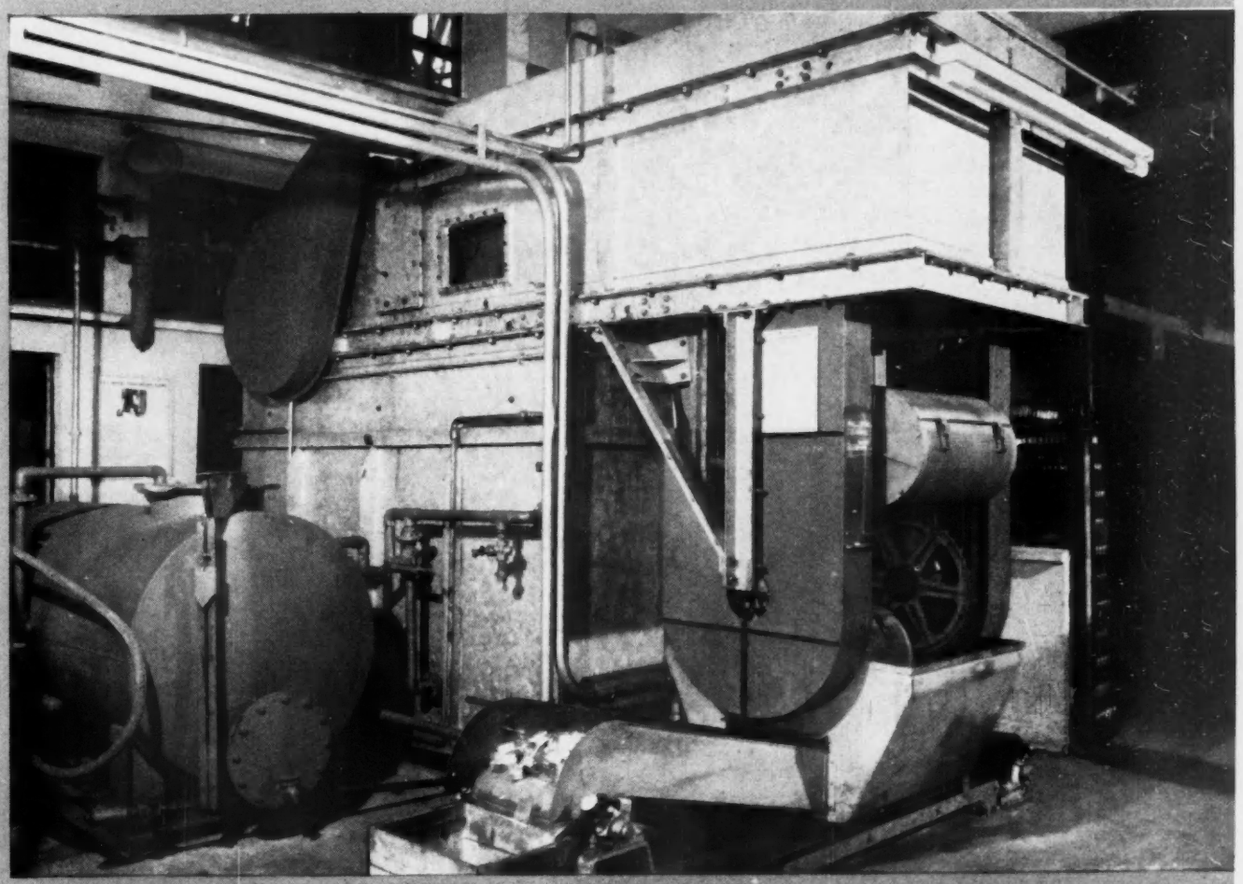
1938 I.C.I. supplied John Dale Ltd. with a mechanised trichloroethylene degreasing plant, to give cold liquor and hot vapour treatment, for cleaning light aluminium impact extruded containers. Work baskets were fed through the plant on a double chain conveyor (see illustration).



The old plant

One good plant sells another



The later plant in service

1957 I.C.I. supplied a second plant, similar to the first, but giving boiling liquor instead of cold liquor treatment. Heating is by a choice of steam or electricity. An interconnected still purifies the solvent. Baskets are now emptied and recharged in about 30 seconds. The hourly throughput is from 35-40 basket loads, each holding some 4 cu. ft. of containers.

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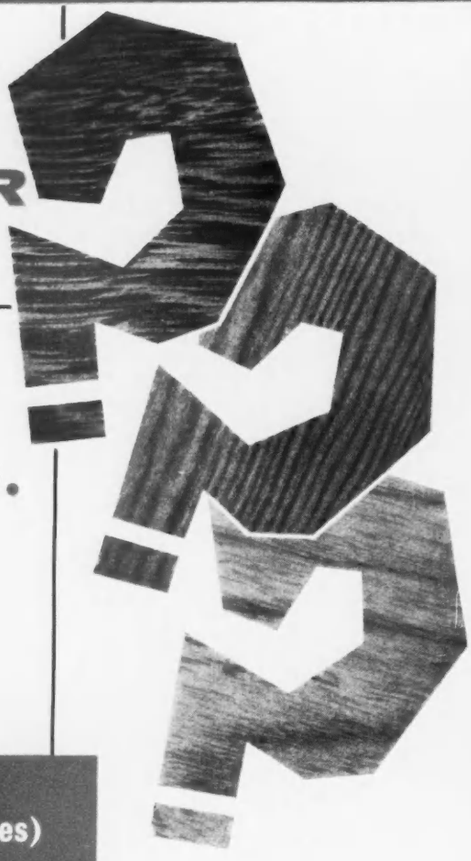

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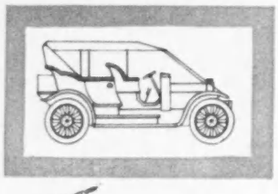

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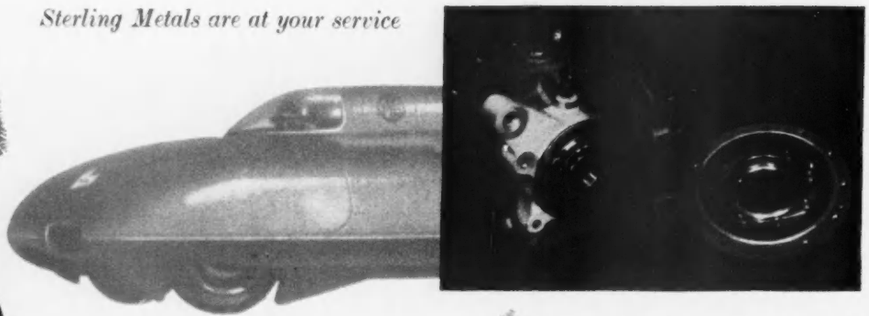

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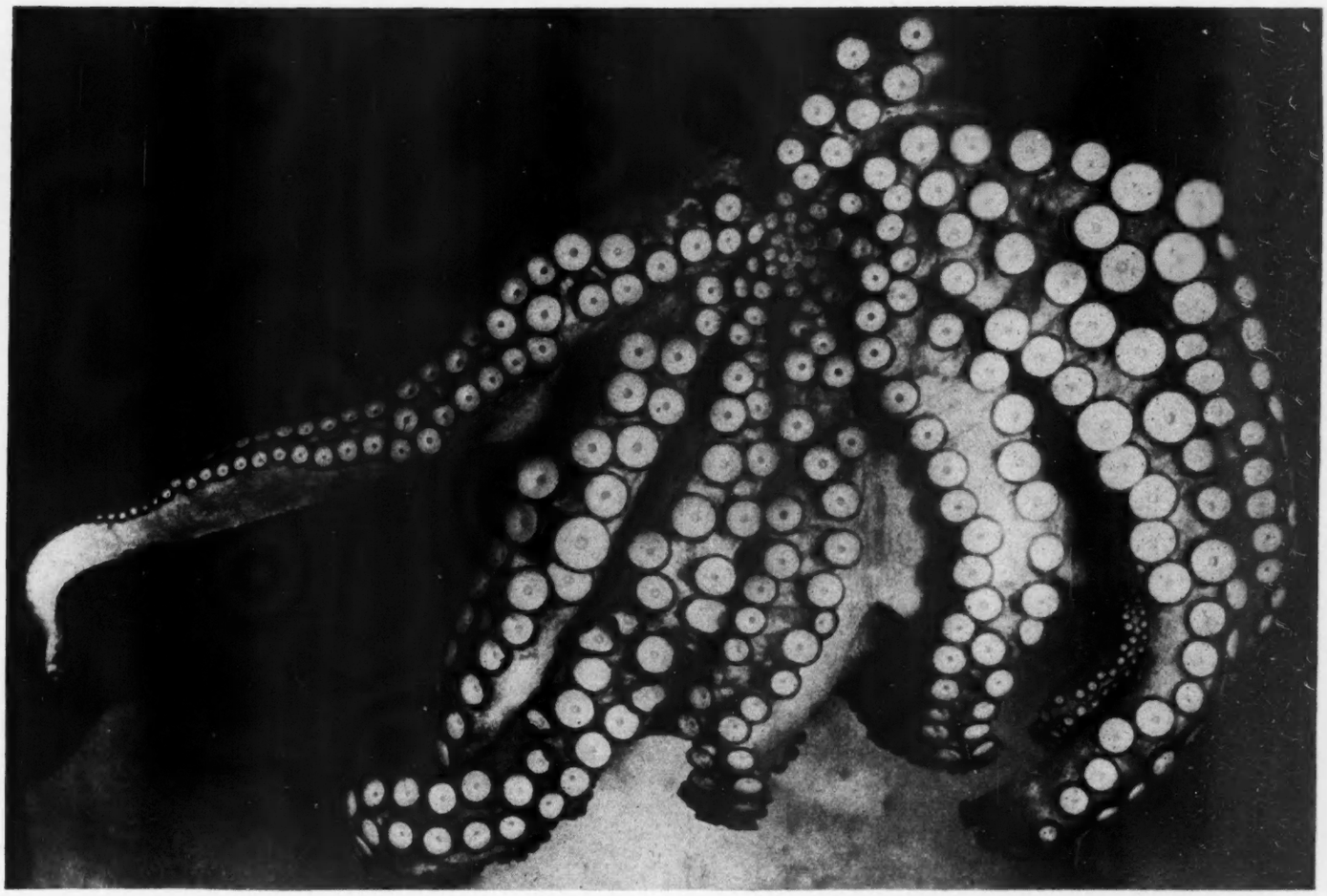

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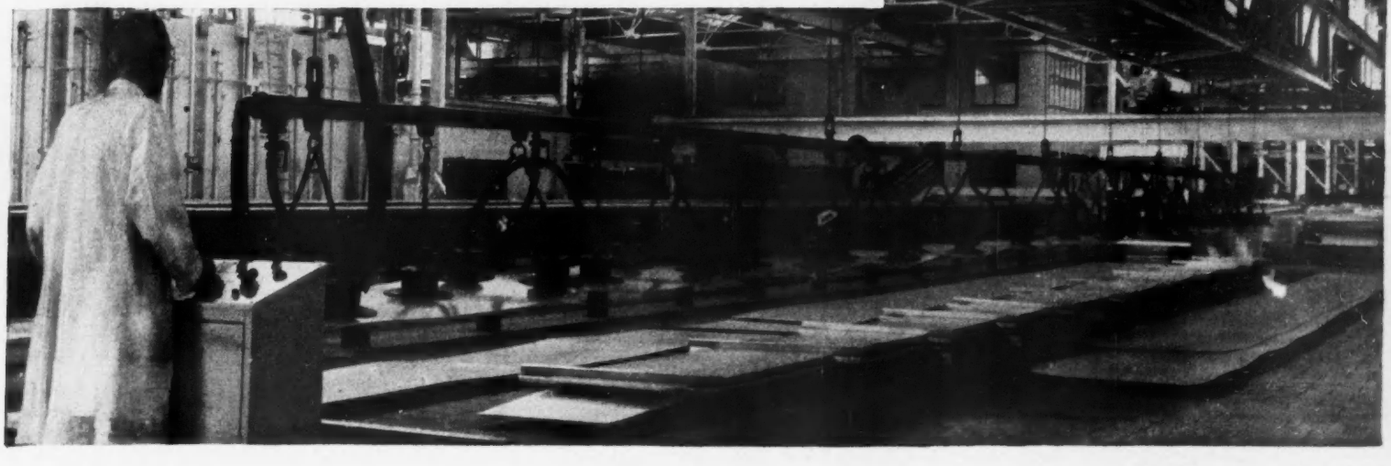

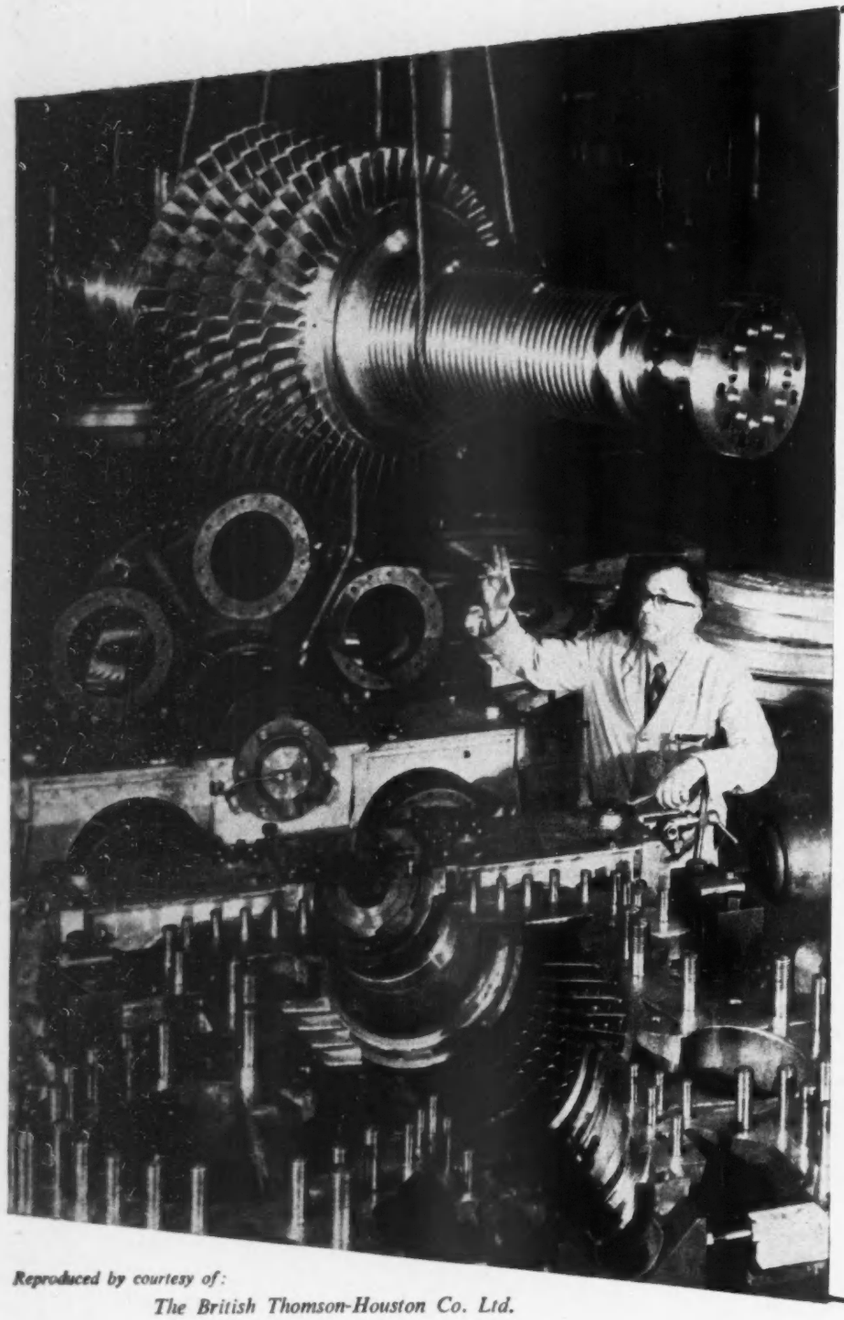

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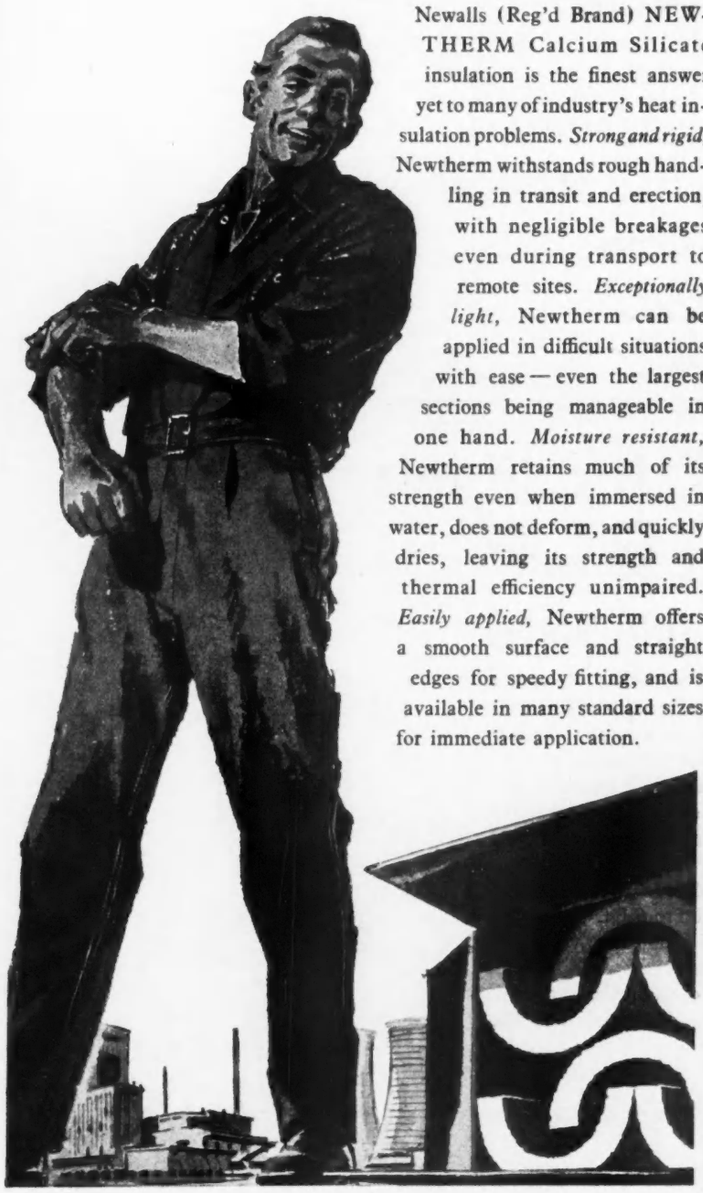

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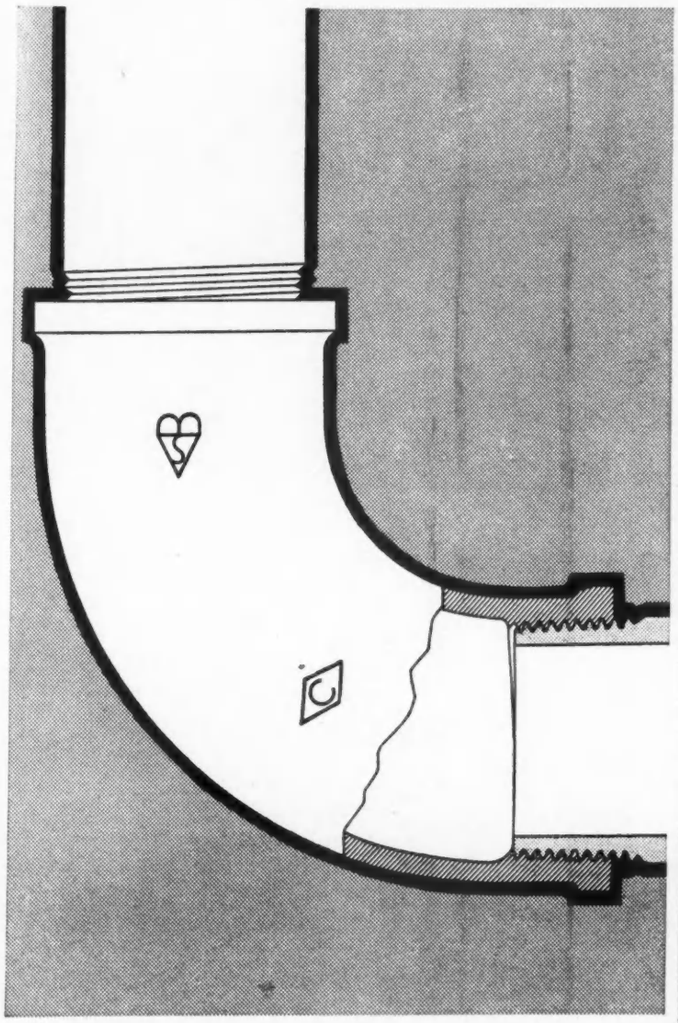

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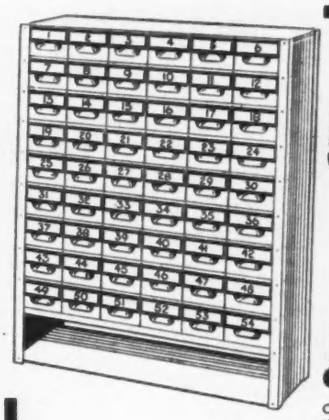

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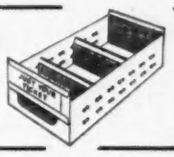

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This gear enables maintenance staff to bring lighting fittings down to floor level so that they can be dealt with quickly and conveniently. It out-dates cumbersome methods and is most economical in time and labour.

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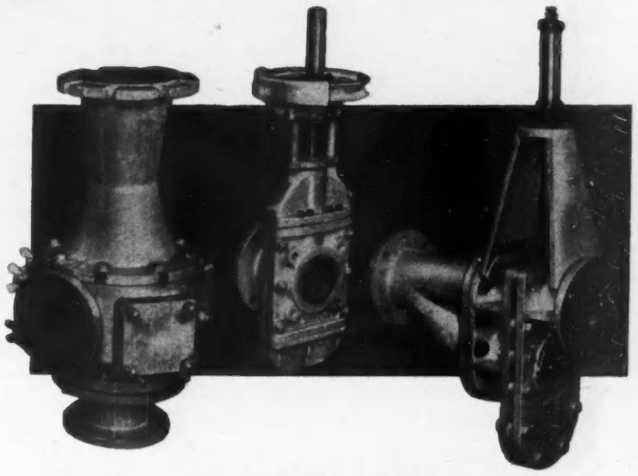

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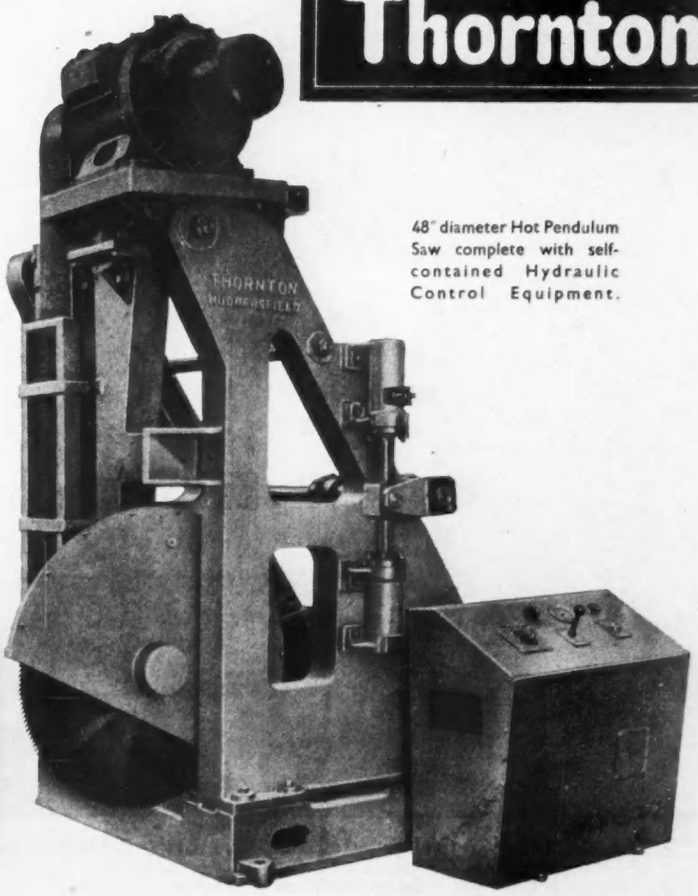

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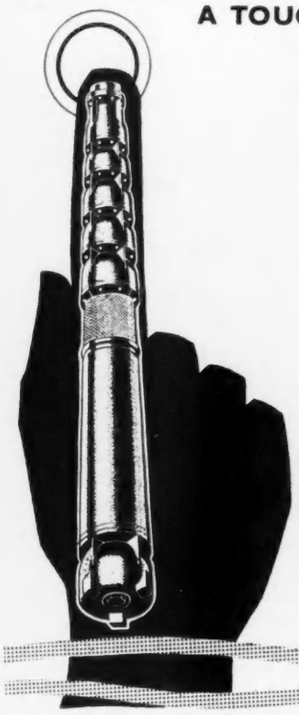

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It's common sense to put the pump where the water is—down the well or borehole. But once it's down there it has to be utterly reliable, so it must be a Beresford submersible pump, rust-proof, self-lubricating, durable. You'll find your Beresford cheap to install, efficient in operation and there's a model designed to raise ample water for your needs, whatever they are. May we send you full details?

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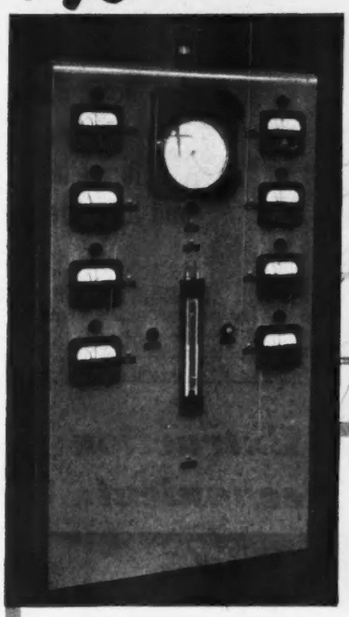

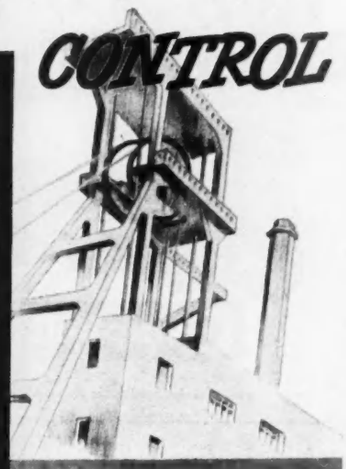

- Acceptable by inspectorate for up to 24 hours exemption (Mines Act 1911).
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Gives positive recording and also visual (easily read) of the Fan Water Gauge, also alarm in the event of low or high readings with a close adjustable differential ● Temperature system highly sensitive and fully compensated ● Panel of robust construction and finished to any BSS colour.

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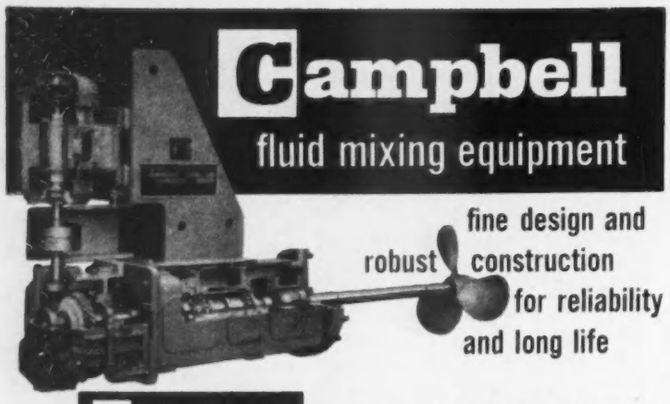

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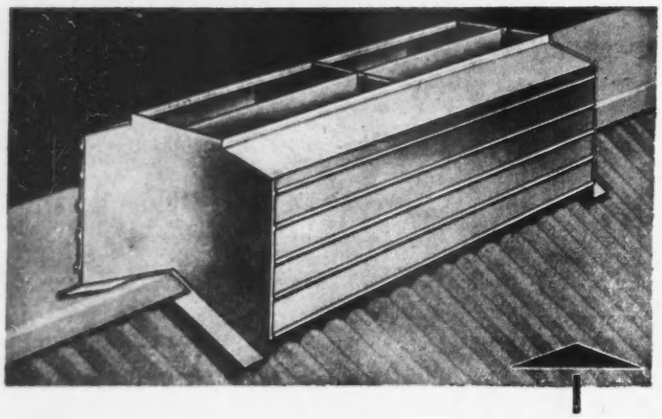

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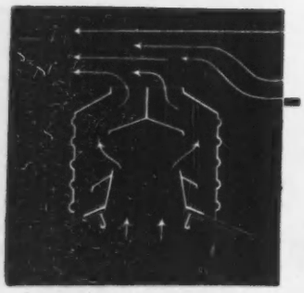

The diagram of a cross-section of the ventilator shows how the air is extracted from the building.

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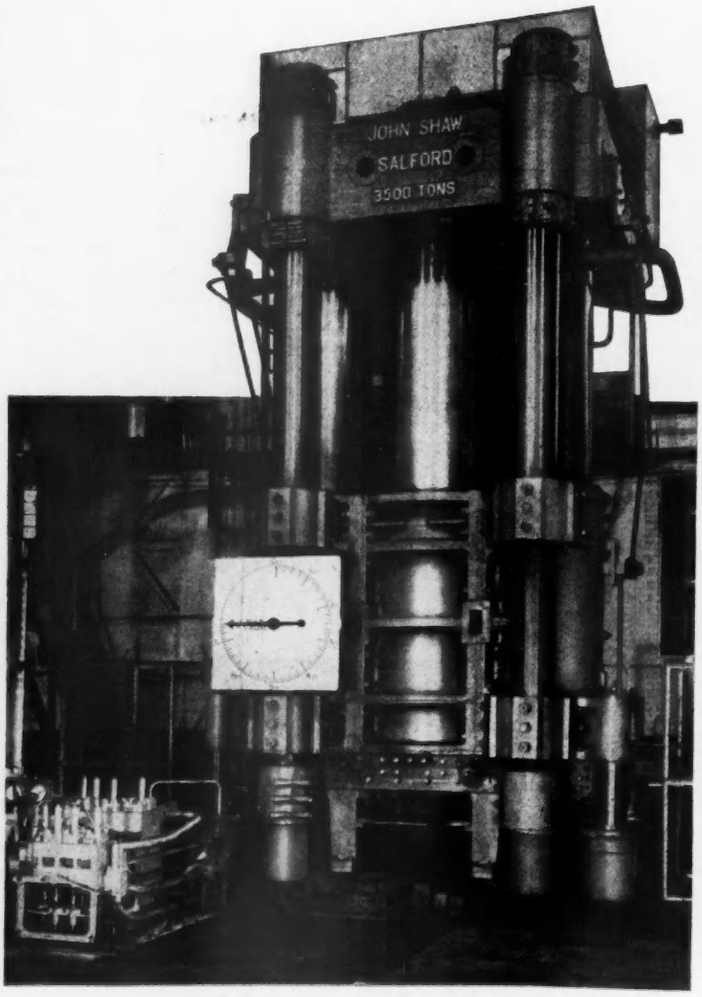

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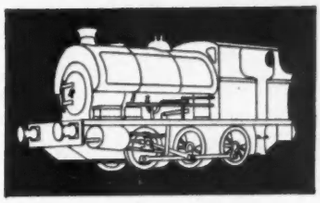

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'MINI-GIANT'
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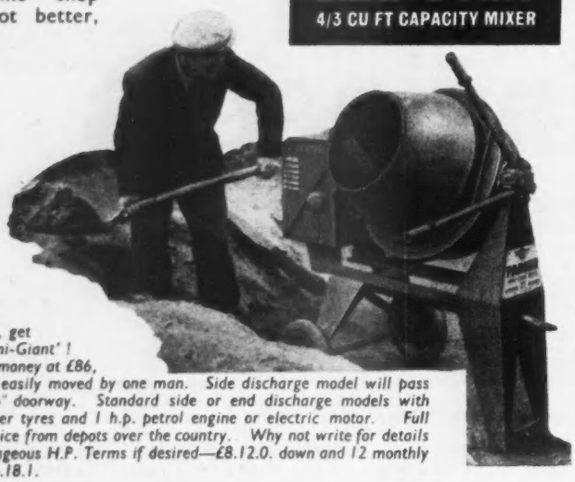

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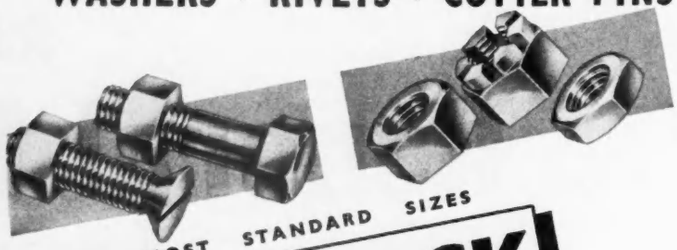

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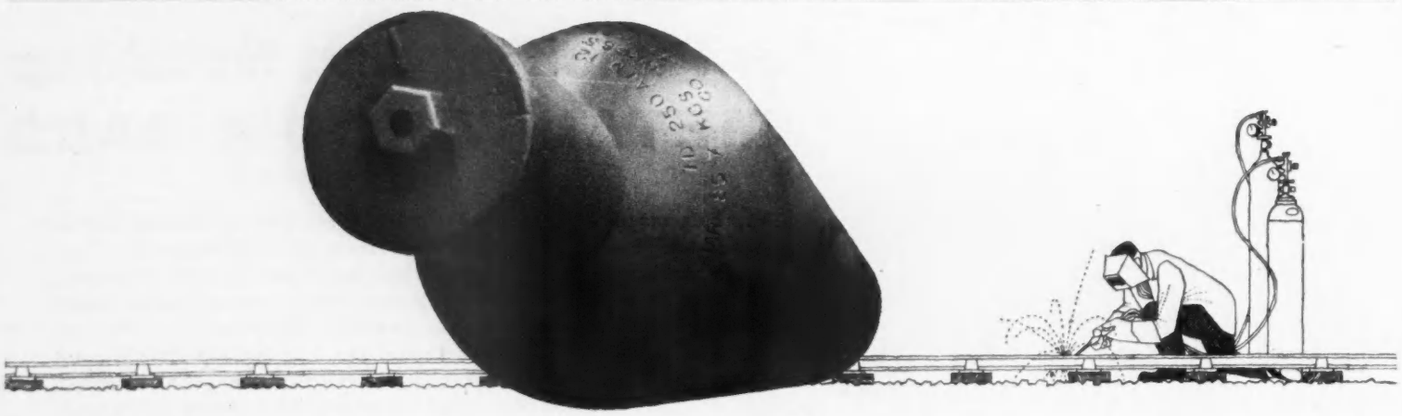

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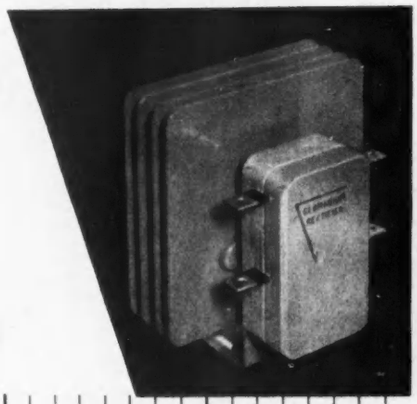

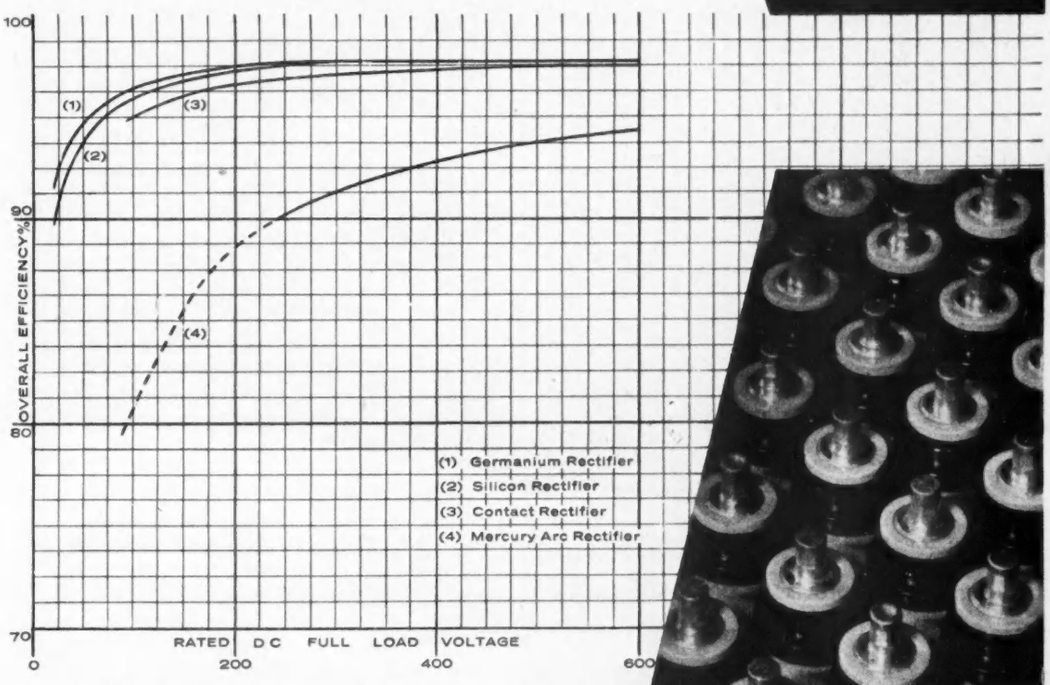

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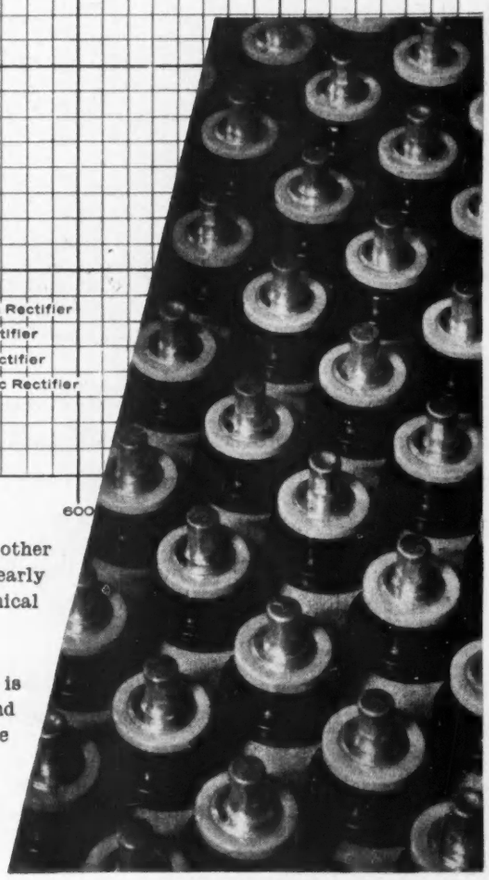

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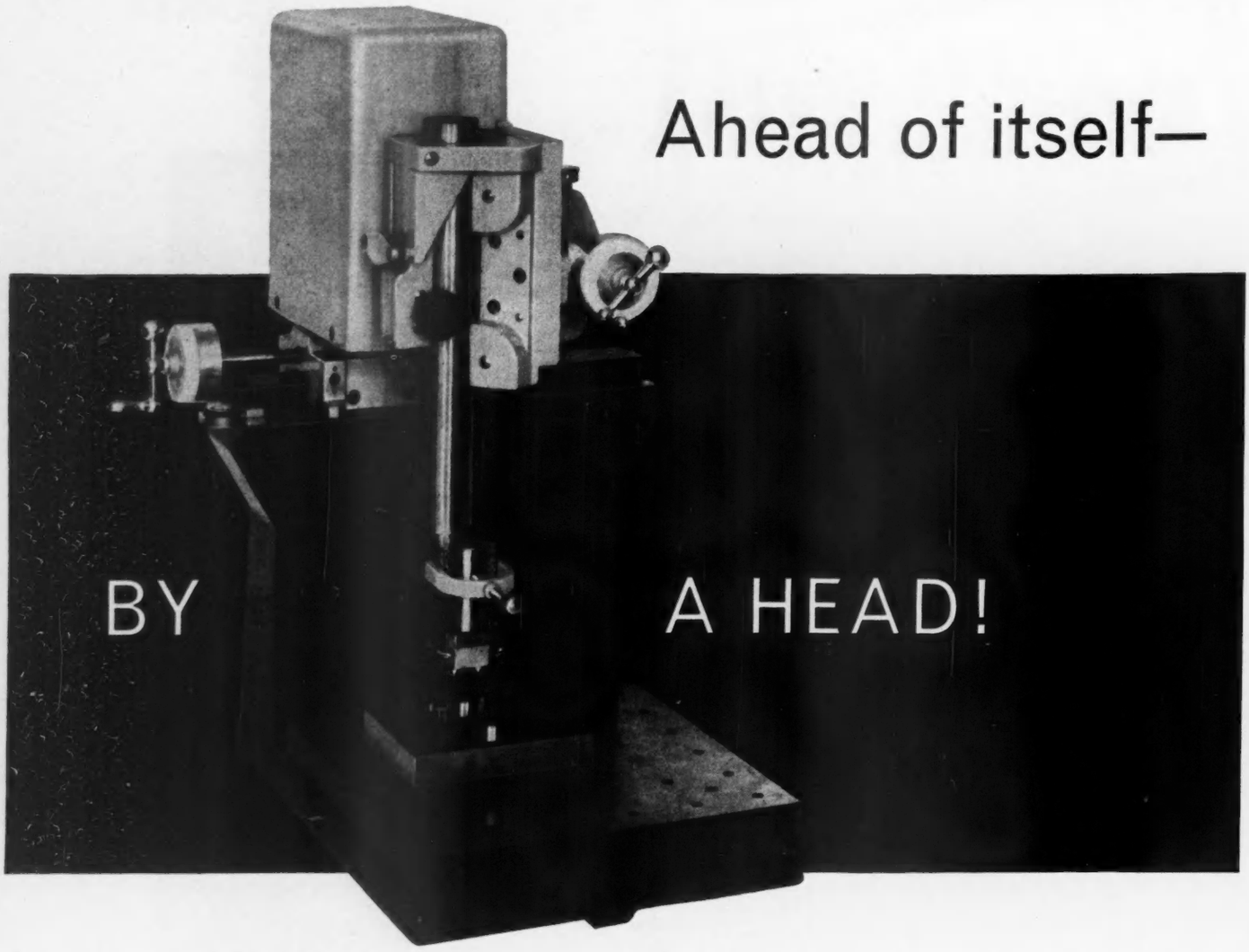

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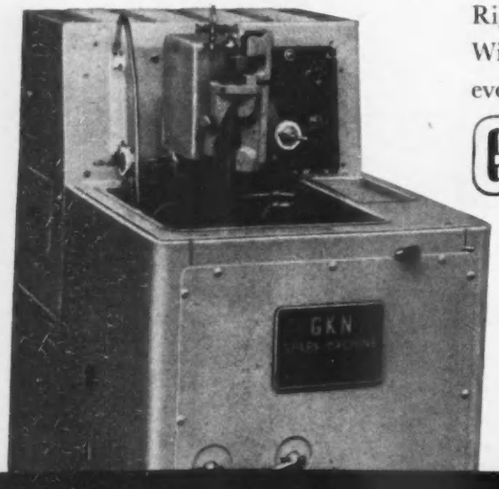

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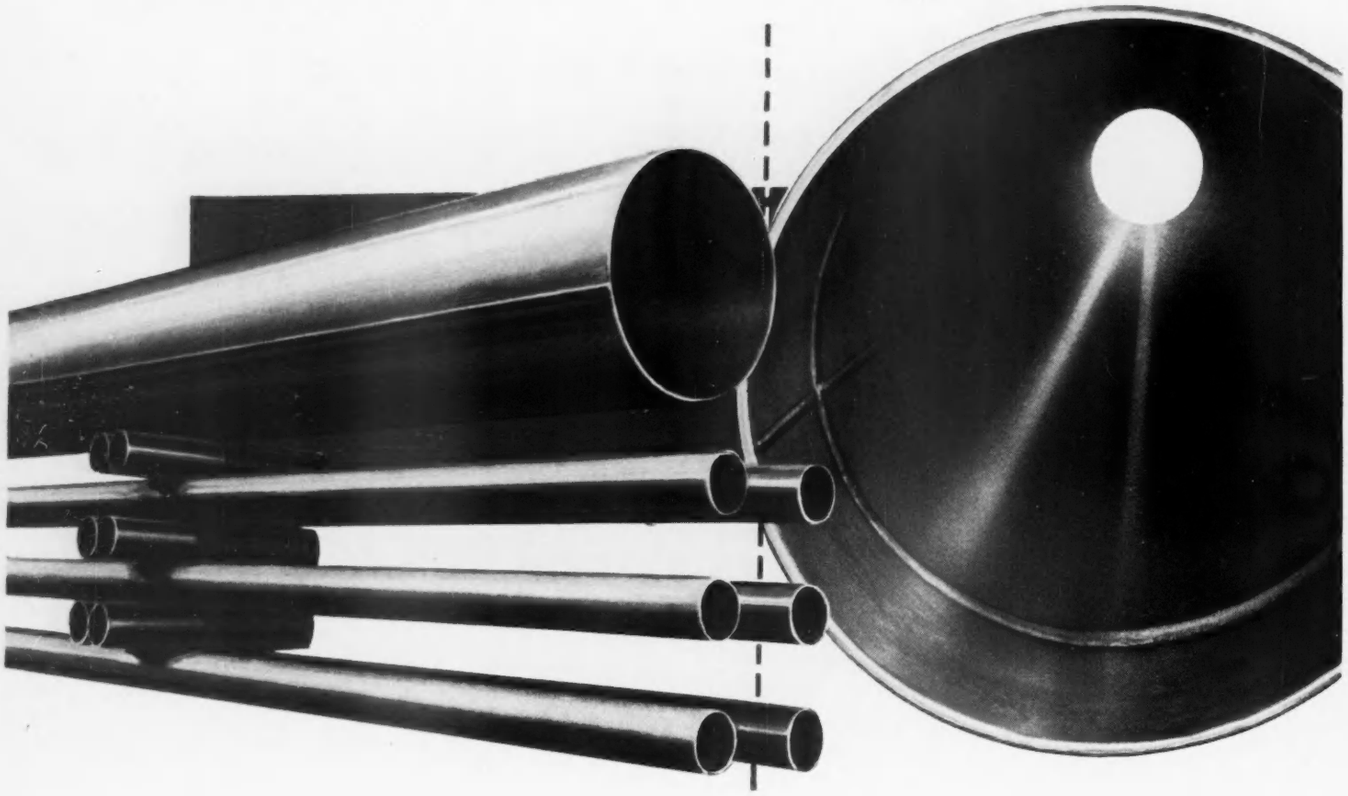

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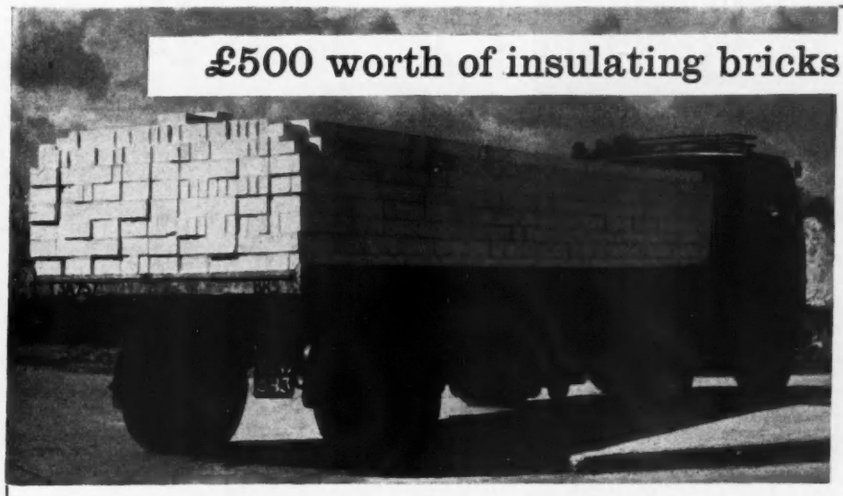
£500 worth of insulating bricks . . .



A consignment of M.P.25 Insulating refractory bricks destined for a Midlands Engineering works

. . . yet without them the furnaces in which they will be installed would consume the equivalent of an extra 65 tons of coal per annum to replace radiation heat losses and higher operational costs. A sound economic reason why Fosalsil Insulating bricks and M.P. Insulating refractories are now an accepted part of modern furnace practice. These high quality materials are designed to give long life and high thermal efficiency in all types of furnaces, boilers, and gas plant.

Medium temperature insulation can also be supplied in slab form—Fosalsil Lightweight Slab Insulation being available in sizes up to 36" × 12". This slightly compressible material possesses superlative insulating properties and is particularly suited for speedy installation over large wall surface areas of plated furnaces.

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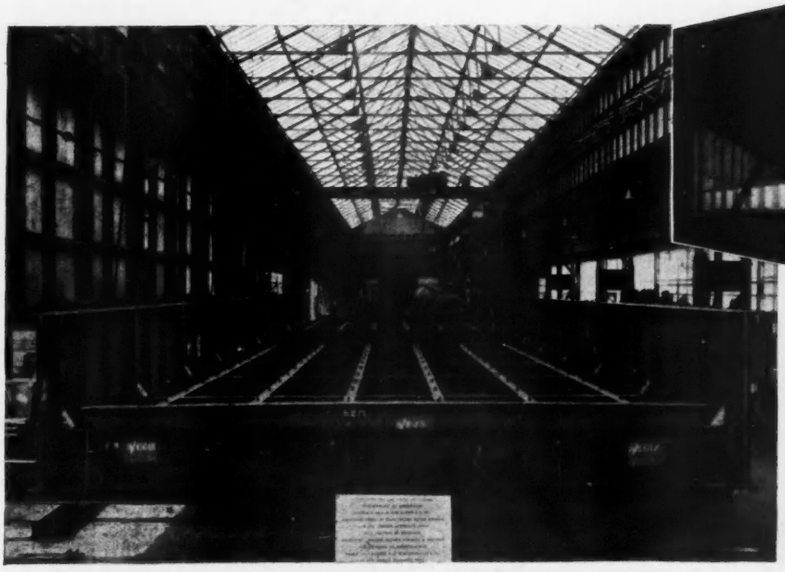
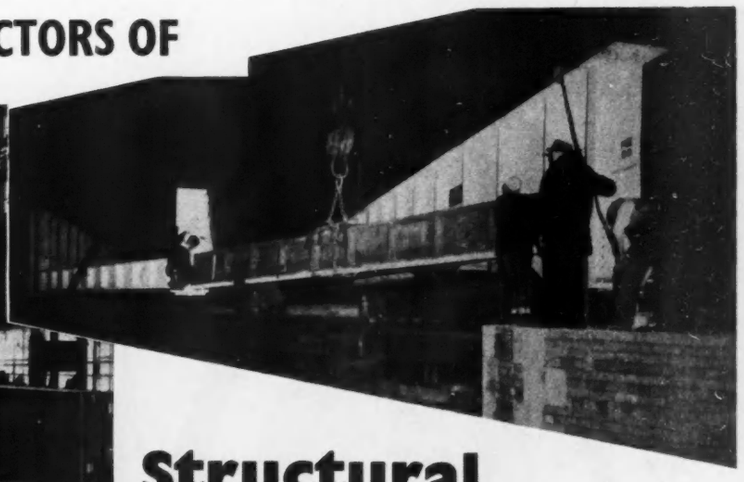
DESIGNERS, FABRICATORS & ERECTORS OF





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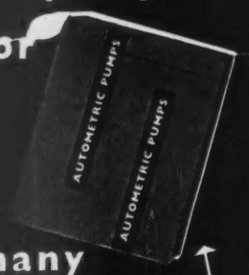

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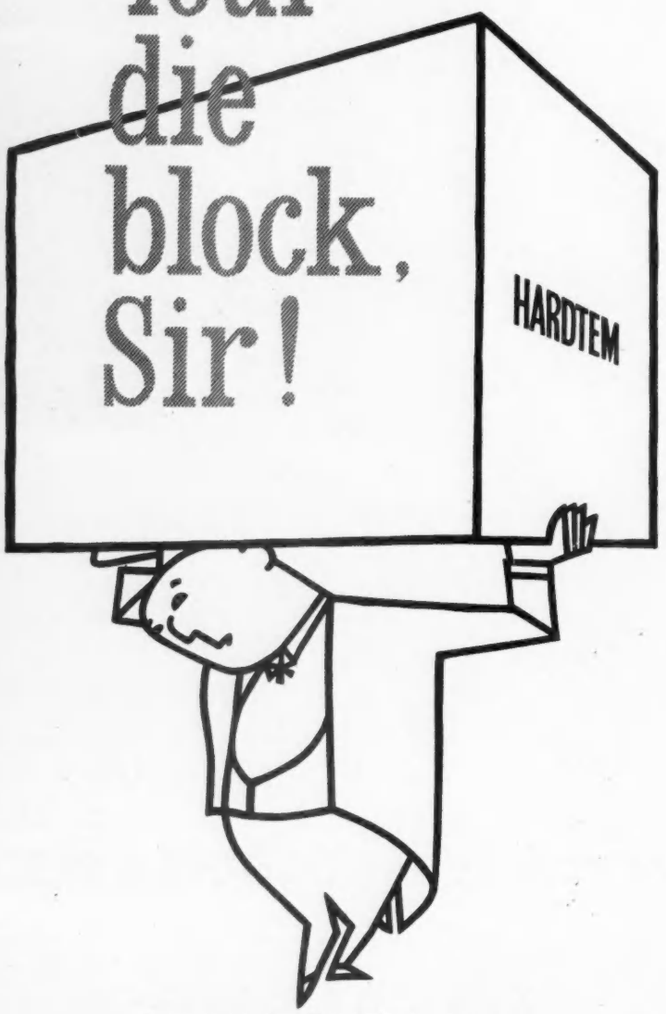
Your die block, Sir!


Service to stamping shops isn't quite as easy as that, but Jessops are now giving rapid delivery of
HARDTEM DIE BLOCKS
now available in weights up to three tons
They can be supplied
either annealed or heat-treated
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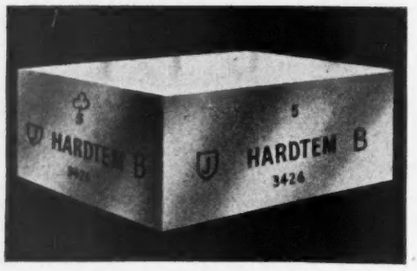

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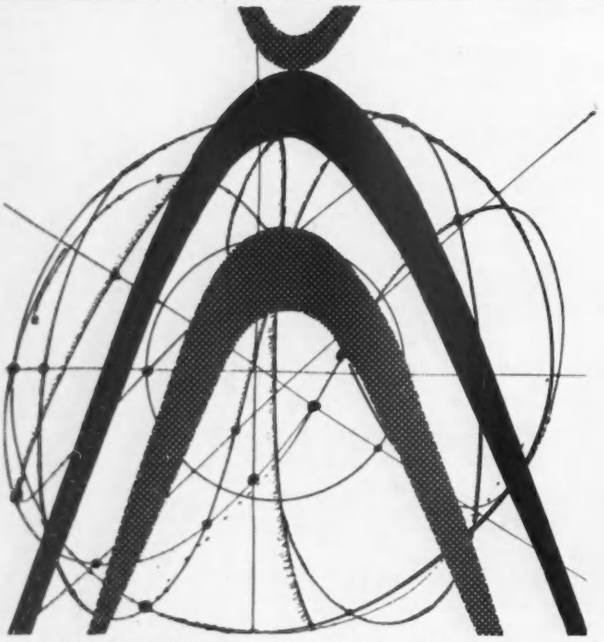
The Place of New Friendships between Customers and Producers of the Five Continents
INTERNATIONAL TRADE FAIR
BRNO, CZECHOSLOVAKIA · 6th-20th September 1959
Total area of exhibition grounds: 520,000 sq. metres
Covered area: 65,000 sq. metres
For 2,000,000 visitors
Products of the engineering and metallurgical industries, raw materials, semi-manufactures and engineering capital and consumer goods are displayed by exhibitors from all parts of the world.
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No matter how you do it, no matter what your particular industrial need, getting in touch with Associated Lead is bound to mean better things—better products, better processes—for you and your industry.

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Recently completed sidings at the new Ravenscraig Works. Photographed by permission of Messrs. Colvilles Limited.

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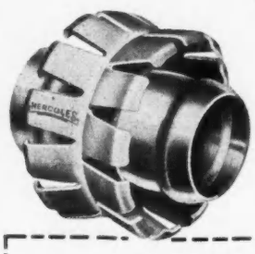
SC.49

"For our HOSE we chose "Hercules" (REGD. TRADE MARK) FITTINGS"



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These Claw-Grips wont let Hose slip!

The strongest, simplest-to-fix Hose Grip ever devised—you simply hammer the claws home! No clips, clamps, wires or special tools needed.

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Within the limits of the law it's full speed ahead on every delivery of LANARKSHIRE bolts. Black, and bright, non-ferrous and high tensile, and nuts too, just as fast as we make them, we deliver them. Try us. And at the same time, ask to be mailed our stock list — sent free every month.

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Use Kay's KONTITE pipe fittings and be sure of a first class job. KONTITE fittings make perfect joints at the turn of a spanner — save time, labour and costs.

There are 22,000 different KONTITE compression fittings, precision-engineered in gunmetal to resist corrosion for all sizes of pipe up to 6" bore.

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CLASSIFIED ADVERTISEMENTS

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Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

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Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

UNIVERSITY OF BIRMINGHAM

LECTURESHIP IN MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING. Candidates should have an Honours Degree in Engineering, together with some practical engineering experience and an interest in thermodynamics. Salary within the range £900 by £50 to £1350; £1350 by £75 to £1650.

Applications (three copies), with the names of three referees, should be sent by 1st October, 1959, to the Deputy Registrar, The University, Birmingham, 15, from whom further particulars may be obtained. E7054

UNIVERSITY OF BRISTOL

DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for a Lectureship (Grade III or II) in the Department of Civil Engineering. Applicants should have good honours degree and some practical experience, preferably in the field of structural steelwork. It is desirable that candidates should be under 35 years of age and have some teaching experience.

Salaries will be in accordance with the following scales:—

Assistant Lecturer (Grade III) £700—£850.

Lecturer (Grade II) £900—£1,300 (bar)—£1,650.

The appointment is to be made as soon as possible and the successful candidate will be required to take up duty not later than the 1st January, 1960. Applications, including the names of two persons to whom reference may be made, should be sent to the Registrar, The University, Bristol 8, from whom further particulars may be obtained. E6957

UNIVERSITY OF GLASGOW

DEPARTMENT OF MECHANICAL ENGINEERING

STEAM POWER SECTION

Applications are invited from Honours Graduates in Engineering for RESEARCH STUDENTSHIPS and ASSISTANTSHIPS, tenable in the above Department. The Studentships are of the value of £550 per annum and the Assistantships of the value of £750 per annum. The appointments are in connection with an extensive programme of research on topics associated with Steam Generation at advanced conditions, which is being carried out under a recurrent grant from the Electricity Supply Research Council.

The work now in progress comprises investigations on the properties of materials at high temperatures, chemical behaviour and transport and thermodynamic properties of steam.

The Research Studentships will be tenable for three years and should normally lead to a higher degree.

Applications (3 copies) should be lodged, not later than 28th August, 1959, with the Secretary of the University Court, The University, Glasgow, W.2.

ROBT. T. HUTCHESON,
Secretary of the University Court. E7011

STOKE-ON-TRENT HOSPITAL MANAGEMENT COMMITTEE

ENGINEERS

Applications invited from suitably qualified and experienced ENGINEERS for the post of DEPUTY SUPERINTENDENT ENGINEER.

Sound knowledge of steam boiler plant and electrical services in large institutions essential, and experience in the design of heating and ventilating systems and estimating will be an advantage.

Salary within range £770–£915 per annum. Whitley Council conditions of service.

Applications by 31st August, 1959, giving age, qualifications and experience, with the names of two referees (one technical), to Group Secretary, Stoke-on-Trent Hospital Management Committee, Princes Road, Stoke-on-Trent. E6995

PUBLIC APPOINTMENTS

BRITISH SHIPBUILDING RESEARCH ASSOCIATION

ATOMIC ENERGY SECTION

APPOINTMENTS

The British Shipbuilding Research Association has vacancies in its Atomic Energy Section for men aged about 25 with a good University Degree in Marine or Mechanical Engineering and with practical training and experience. Research experience an advantage. The persons appointed will be required in the first instance to work in the Association's team at Harwell, studying the possible application of nuclear power to merchant ship propulsion. Experience of nuclear energy is not an essential qualification, as training in this will be given. The commencing salaries will depend upon age and qualifications and the appointments are subject to the Federated Superannuation System for Universities.

Applications, with full particulars, should be addressed to: B.S.R.A., 5, Chesterfield Gardens, Curzon Street, London, W.1. E7017

PORT OF BRISTOL AUTHORITY

TWO ENGINEERING ASSISTANTS

Applications invited for above posts. Candidates should be capable of preparing schemes with minimum of supervision from initial survey through calculations and preparation of drawings to final contract documents. Experience in dock engineering useful but not essential.

Salary: £1065 by £50 per annum to £1220. Commencing salary within this range will depend upon age, qualifications and experience. Medical examination and six months' probationary period. Post pensionable.

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age, qualifications, experience, &c., and enclosing, if possible, copies of recent testimonials, in envelopes endorsed "Engineering Assistants," to Engineer-in-Chief, Avonmouth Docks, Bristol, by 11th September. E7056

TEES VALLEY AND CLEVELAND WATER BOARD

LARTINGTON FILTRATION WORKS

APPOINTMENT OF RESIDENT ENGINEER

The Board invites applications for the appointment of a RESIDENT ENGINEER—Lartington Filtration Works, at a salary within the range of Grade A.P.T. V of the National Salary Scales (£1220–£1375), depending upon qualifications and experience of the applicant.

Applicants should be Corporate Members of the Institution of Civil Engineers and have had a sound technical and practical experience in the design and construction of water retaining structures and building work, including supervision of contracts.

The person appointed to the post will be responsible for the supervision of works carried out by contract; for the execution of such works in accordance with the designs and specifications prepared by the Board; for the interpretation of such designs and specification; and the carrying out of additional and/or amended design work on site under the direction of the Board's Engineer, New Works, &c.

The appointment will be for the duration of approximately 2–3 years and the successful candidate must devote his whole time to the work of the Board and will be required to pass a medical examination. The appointment will be subject to the provisions of the Local Government Superannuation Acts, 1937–1953.

Applications endorsed "Resident Engineer—Lartington Filtration Works," stating age, qualifications and experience, accompanied by three recent testimonials, must reach the undersigned by Tuesday, 1st September, 1959.

E. A. MORRIS,
Clerk of the Board and Chief Executive Officer.

Water Board Offices,
Corporation Road,
Middlesbrough. E7009

PUBLIC APPOINTMENTS

BOROUGH OF SUTTON AND CHEAM

APPOINTMENT OF MAINTENANCE ENGINEER

Applications are invited for the appointment of a MAINTENANCE ENGINEER at the Council's Sewage Purification and Refuse Disposal Works.

The salary will be within Grade Miscellaneous VI (£715 to £775 per annum), in accordance with the National Scale of Salaries, plus London "Weighting," £20/£30 per annum. The commencing salary will be according to ability and experience. The person appointed will work under the direction of the Sewage Works Manager and will be responsible for the running and maintenance of diesel oil and gas engines, generators and switchboards, centrifugal pumps and air compressors. Experience in the supervision and running of sewage treatment and pumping plant at a Sewage Works is not essential but will be considered an advantage.

Housing accommodation is available.

The appointment, which is terminable by one month's notice in writing on either side, is on the permanent staff of the Corporation, is subject to the provisions of the Local Government Superannuation Acts, 1937 to 1953, and to the National Scheme of Conditions of Service.

The successful candidate will be required to pass a medical examination.

Further details of the appointment and a form of application may be obtained from Mr. C. Needham, M.I.C.E., M.I.Mun.E., A.M.I.Struct.E., Borough Engineer and Surveyor, to whom it should be returned accompanied by copies of two recent testimonials, not later than the 31st August, 1959, endorsed "Maintenance Engineer." Applicants must state whether they are related to any member or holder of any senior office under the Borough Council. Canvassing in any form will disqualify.

A. PRIESTLEY,
Town Clerk.

Municipal Offices,
Sutton, Surrey.
August, 1959. E7065

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Vacancies for SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in following localities:

LONDON AREA: MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles: knowledge of theoretical hydrodynamics and theory of control systems an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICISTS for acoustic analysis. ELECTRONIC PHYSICISTS for data handling and analysis problems. PHYSICIST interested in operator performance. CLASSICAL PHYSICISTS.

BALDOCK: PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH: ELECTRONIC ENGINEERS for research on analogue computers and transistor circuits. ELECTRICAL ENGINEERS for research on small rotating electrical machinery. PHYSICISTS—for optical systems and instrumentation. ELECTRO-MECHANICAL ENGINEERS—for work on servo-mechanisms.

PORTLAND: PHYSICISTS or APPLIED MATHEMATICIANS for research on underwater acoustics. ELECTRONIC PHYSICISTS, ELECTRONIC ENGINEERS—for design work. PHYSICAL CHEMISTS.

POOLE: CHEMICAL ENGINEERS. CHEMISTS for work on rubber technology.

ROSYTH: PHYSICISTS—(Electronic).

Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Hons. Degrees, S.S.Os. must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men): S.S.O., £1233–£1460; S.O., £655–£1150 (London), somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.220/9A). E7037

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

PATENT EXAMINERS AND PATENT OFFICERS

Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 28 (35 for Examiners), with extension for regular Forces Service and Overseas Civil Service.

Qualifications: normally First or Second Class Honours Degree in Physics, Chemistry, Engineering or Mathematics, or equivalent attainment, or professional qualification, e.g., A.M.I.C.E., A.M.I. Mech.E., A.M.I.E.E., A.R.I.C., London salary (men) £655 to £1460; provision for starting pay above minimum. Promotion prospects.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S128/59, and stating date of birth. E7036

SOUTHAMPTON CORPORATION WATERWORKS

CIVIL ENGINEERING ASSISTANT

Southampton Corporation Waterworks require CIVIL ENGINEERING ASSISTANT, age not exceeding 35. Must have passed Parts 1 and 2 Institution of Civil Engineers or exempting examination. Experience in waterworks advantageous. Salary: A.P.T. "Special Scale" (£785/£1070).

Conditions of appointment from C. A. Bradley, B.Sc., M.I.C.E., Waterworks Engineer, Civic Centre, Southampton. Applications by Monday, 31st August, 1959. E7033

THANET WATER BOARD

DEPUTY SUPPLY ENGINEER

Applications are invited for the above appointment at salary Miscellaneous Grade VI (£715 by £20 to £775). Wide experience in the operation and maintenance of steam, diesel and electrical pumping and treatment plant.

House provided at moderate rental.

The appointment is subject to satisfactory medical examination, to the provisions of the Local Government Superannuation Acts, and is terminable by one month's notice on either side.

Further particulars and forms of application from the Engineer and Manager, 58, Victoria Road, Margate, to whom applications should be addressed, endorsed Deputy Supply Engineer, not later than 5th September, 1959. Canvassing will disqualify. E7038

CITY AND COUNTY OF KINGSTON UPON HULL

WATER DEPARTMENT

SENIOR MECHANICAL ENGINEERING ASSISTANT

Applications are invited for the appointment of a SENIOR MECHANICAL ENGINEERING ASSISTANT at a salary within Grade V, A.P.T. Division of the National Joint Council's Scales (£1220 to £1375 per annum), according to qualifications and experience.

Applicants should be Corporate Members of the Institution of Mechanical Engineers and/or Institution of Electrical Engineers, and must have had considerable experience in the design, installation and maintenance of all types of large pumping plants.

The appointment will be subject to one month's notice on either side, to the National Scheme of Conditions of Service, to the Local Government Superannuation Act, 1937, and to the passing of a medical examination.

Housing accommodation may be available, if required.

Applicants should give details of age, education and training, qualifications, present and previous appointments and experience.

Applications, with copies of two recent testimonials must reach the undersigned not later than the 22nd August, 1959.

Any applicant canvassing a member of the City Council or Chief Official will be disqualified.

T. H. JONES, M.I.C.E.,
Engineer and Manager.

Water Department,
Alfred Gelder Street,
Kingston upon Hull. E7074

PUBLIC APPOINTMENTS

CITY OF SHEFFIELD

APPOINTMENT OF GROUP LEADER (SURVEYOR)
GRADE A.P.T. V. SALARY £1220–£1375

Applications are invited for the above-mentioned appointment on the permanent staff of the City Architect, Mr. J. L. Womersley, F.R.I.B.A., Dist.T.P., M.T.P.I.

The successful applicant will be required to take charge of the Survey Group which is responsible for the survey and levelling of sites for all types of development carried out by the Department, the design and construction of road and sewer works, playing fields and public open spaces and the co-ordination of utility services in connection with new building work, both in the outer areas and redevelopment of the inner areas of the City.

Applicants must hold a suitable qualification and preference will be given to Chartered Civil or Municipal Engineers.

Applications, stating age, education and training, qualifications, experience, present and past appointments (with dates and salaries) and the names and addresses of persons to whom reference may be made, should reach the undersigned by Monday, 7th September, 1959.

JOHN HEYS,
Town Clerk.

6th August, 1959. E7047

PUBLIC APPOINTMENTS

WELLAND RIVER BOARD AND SOUTH HOLLAND LAND DRAINAGE BOARDS

SUPERINTENDENT FITTER—HOLBEACH WORKSHOPS

Applications are invited for the above post in the salary range Grade A.P.T. III (£880–£1065) under the N.J.I.C. conditions of service. The post will be superannuated and travelling allowance will be paid in accordance with the above scales. The successful applicant will be expected to reside in or near Holbeach.

The person appointed will be required to take charge of the Boards' workshops and be responsible for the maintenance and repair of all the Boards' plant and equipment, including sluices and pumping stations with electric motors and control gear. He will also be responsible for the supervision of the other fitters and be expected to work with them on the repair and overhaul of plant.

Applications, giving age, experience and present position, with the names of two referees, should be forwarded as soon as possible to :—

R. L. G. Baxter, A.M.I.C.E., Chief Engineer, Welland House, Double Street, Spalding. E6996

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By Louis Toft, M.Sc., and A. T. J. Kersey, A.R.C.Sc., etc. 6th Edition. This up-to-date textbook covers the syllabuses of the B.Sc. (Eng.), Inst.C.E., examinations in this subject. A standard work on the subject. 30/- net.

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When electronic engineering is studied "Electronic Engineering" is read.

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28 ESSEX STREET, STRAND, W.C.2

Telephone : Central 6565

Published by Morgan Bros. (Publishers) Ltd.

PUBLIC APPOINTMENTS

BRENTRY HOSPITAL, WESTBURY-ON-TRYM, BRISTOL

ASSISTANT ENGINEER

ASSISTANT ENGINEER required at this Hospital (440 beds). Salary £545 by £20 (1) by £25 (3) by £30 (1) to £670 ; commencing salary according to experience up to two increments above minimum. Candidates must have completed an apprenticeship or otherwise acquired sound practical training in mechanical engineering.

Applications with age, qualifications and experience, and names of three referees, to Group Secretary. E7068

TENDERS

CITY AND COUNTY OF BRISTOL

MAIN FOUL WATER DRAINAGE SCHEME

MAIN PUMPING STATION

Experienced manufacturers of Propeller Pumps, Motors and Ancillary Equipment are invited to APPLY FOR INCLUSION in a selected list of firms who will be invited to TENDER for the SUPPLY and ERECTION of AUTOMATIC PUMPING PLANT for the above.

Six pumps will be required in the first instance, each to discharge about 20,000 gallons per minute against a mean total static head of about 27ft. Two of the pumps will be equipped with variable pitch impellers and the sewage will pass through comminutors or screens prior to pumping.

Applications, with supporting evidence of similar experience, to City Engineer and Planning Officer, Cabot House, Deanery Road, Bristol, 1, by 28th August. E7057

BUCKS WATER BOARD

MID BUCKS SCHEME

Applications are invited from experienced CONTRACTORS (items 1–3) and from actual MANUFACTURERS (items 4–14) who desire to be considered for INCLUSION on an APPROVED TENDER LIST for any of the items listed below, all in accordance with the Board's Standing Orders, Conditions of Contract and Specifications.

1. R.C. Reservoirs. 2 and 3 m.g.
2. 21in. and 24in. prestressed concrete and 18in. asbestos pipe laying (excluding supply of pipes). (About 23 miles.)
3. 12in. and 15in. asbestos pipe laying (excluding supply of pipes). (About 12 miles.)
4. Cast iron pipes and specials.
5. Asbestos cement pipes and specials.
6. High pressure prestressed concrete pipes and specials.
7. High pressure sluice valves and ancillary fittings.
8. High pressure rotary type plug valves.
9. High pressure submersible pumps.
10. Electrically driven booster pumps.
11. Continuously rated heavy duty starters.
12. Chlorinators and residual recorders.
13. Communication and instrumentation equipment (operating and recording intelligencies over 60 miles of private Post Office telephone lines and cables including Control and Sub-station equipment).
14. Multi-core plastic wired armoured communication cables.

Applicants must state if they are willing to consider fixed price tenders and they should note that all goods and materials are to be British (including Commonwealth) and carried in British ships and that only selected applicants will be invited to tender. In addition, applicants for items 1, 2 and 3 shall give details of their experience and of their organisation.

Separate applications for each of the above items must be received by the undersigned not later than noon on Tuesday, 1st September, and each envelope shall be clearly endorsed with the correct item number.

H. A. FOLEY,
Clerk of the Board.

7, Temple Square,
Aylesbury.
7th August, 1959. E7072

COQUET WATER BOARD

FILTRATION WORKS AND PUMPING STATION, WARKWORTH

TENDERS are invited from experienced civil engineering contractors for the PROVISION of MATERIALS, CONSTRUCTION, COMPLETION and MAINTENANCE for a period of twelve months of the above works which comprise :—

High Lift Pumphouse Sump, Rapid Gravity Filters, Sedimentation Tanks, Washwater Settlement Tanks, Clear Water Tank (5 million gallons capacity), Pipelines and ancillary works at Warkworth, Northumberland.

Contract documents and general arrangement drawings will be forwarded upon payment of a deposit of Ten Guineas (which will be refunded upon the receipt of a bona fide Tender and the return of all contract documents) by the Engineer and Manager of the Coquet Water Board, Newcastle and Gateshead Water Company's Offices, G.P.O. Box 104, Pilgrim Street, Newcastle upon Tyne, 1.

Detail drawings may be inspected at the offices of the Engineer and Manager.

Tenders, duly completed, must be returned in the envelope provided, addressed to the undersigned not later than 10.30 a.m., Monday, the 21st September, 1959. The Board does not bind itself to accept the lowest or any Tender.

FRED. G. EGNER,
Clerk and Solicitor.

14, Northumberland Square,
North Shields. E7010

TENDERS

INDIA SUPPLY MISSION

The Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, 8, D.C., U.S.A., invites TENDERS for the following.

TENDER ENQUIRY No. SE.74

For the SUPPLY of LIGNITE CARBORISATION and BRIQUETTING PLANT, capacity 1000 tons per day approximately, for Neyveli Lignite Corporation, Madras.

TENDER ENQUIRY HQ. SE.75

For the SUPPLY of COAL MINING MACHINERY, DRAGLINES, SHOVELS, DOZERS, CRANES, DRILLS, TRACTORS, &c., for National Coal Development Corporation, Ltd.

Specifications, &c., relative to the above, can be obtained for Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, London, W.3, at a cost of £2 2s. 10d. for SE.74 and £1 1s. 5d. for SE.75. Tenders are to be returned direct India Supply Mission, U.S.A., at above address, so as to reach them by 29th September and 9th September respectively.

Specimen copies of Tender forms can be seen at C.D.N. Branch, India Store Dept., Bromyard Avenue, Acton, London, W.3, under references S.3424/59 and S.3425/59. E7005

LEE CONSERVANCY CATCHMENT BOARD

FLOOD ALLEVIATION SCHEME

CONTRACT NO. 18

TENDERS are invited for the following WORKS in the Borough of Tottenham in the County of Middlesex :—

(a) CONSTRUCTION of about 3920ft. of REINFORCED PRECAST CONCRETE CULVERT of widths varying from 7ft. to 18ft. and height about 7ft., generally replacing an existing culvert, including railway and road crossings.

(b) DEMOLITION of about 2600ft. of existing CONCRETE CULVERT of width 9ft. and height 4ft. 6in.

(c) CONSTRUCTION of FOUL and SURFACE WATER SEWER DIVERSIONS.

(d) FILLING, SOILING, SEEDING, FENCING and other Appurtenant Works.

Instructions to Tenderers, documents and site plan are obtainable from N. Medrington, Esq., A.M.I.C.E., M.I.W.E., Engineer to the Board, at "The Grange," Crossbrook Street, Cheshunt, Herts. (telephone : Waltham Cross 24211), on payment of £5, returnable under certain conditions. Documents and detail drawings may be inspected without payment at the Engineer's Office. Copies of detail drawings may be obtained on loan. Tenders are to be delivered to the undersigned before 12 o'clock noon, B.S.T., on the 14th September, 1959.

J. L. SPILLER,
Clerk of the Board.

The Lee Conservancy Catchment Board,
Brettenham House,
Lancaster Place,
Strand,
W.C.2. E6993

WARWICKSHIRE COUNTY COUNCIL

TO HEATING AND ELECTRICAL ENGINEERS

Firms desirous of having their names placed upon a LIST OF APPROVED CONTRACTORS from whom the Warwickshire County Council will invite TENDERS for schemes costing £1250 and over for :

1. HEATING, HOT AND COLD WATER SUPPLIES, GAS AND STEAM SERVICES and/or
2. ELECTRIC LIGHT AND POWER INSTALLATIONS,

should make application on or before Monday, 7th September, 1959, to G. R. Barnsley, F.R.I.B.A., County Architect, Shire Hall, Warwick.

When submitting their applications, applicants must clearly indicate the maximum financial amount of individual contracts for which they wish to be considered and must forward particulars of contracts recently executed by them, giving the names and addresses of local authorities or persons to whom reference can be made.

Tenders will be considered only from firms included in the official list which will be compiled by the appropriate Committee after consideration of applications.

Contractors whose names are already included on the Council's approved list need not make application.

L. EDGAR STEPHENS,
Clerk of the Council.

Shire Hall,
Warwick.
June, 1959. E7078

EDUCATIONAL

UNIVERSITY OF MANCHESTER

THE NEXT SESSION COMMENCES ON TUESDAY, 13th OCTOBER, 1959. E7029 B

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 B

ELECTRONICS, covering practical and theoretical aspects, basic principles, Industrial applications, electronic apparatus, &c. Guaranteed coaching for Brit.I.R.E., City and Guilds, &c. Study at home under highly qualified tutors.—Write for free book : International Correspondence Schools, 71, Kingsway (Dept. 446A), London, W.C.2. E157 B

Classified Advts. continued on page 104

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A DESIGN/DRAUGHTSMAN required by expanding Engineering Company for new Factory being erected in East Anglia. A good knowledge of plant layout, mechanical handling, automatic feed mechanisms coupled with general factory services is required. Previous experience is essential. H.N.C. level preferred. Production engineering or Works Study experience an advantage. Initially posted in Essex, later East Anglia. Attractive working conditions. Part-contributory pension and life assurance scheme. Salary commensurate with age, experience and qualifications. Write giving full details of career to Box No. E6940, "The Engineer".

APPLICATIONS ARE INVITED for the appointment of ASSISTANT MANAGER of a modern solvent extraction plant in Kenya. The minimum technical qualifications are the Higher National Certificate in Mechanical Engineering or equivalent. Experience of chemical plant operation is essential and experience of the following advantageous :—Electric motors and control gear, automatic control instruments, plant installation, maintenance of heavy machinery, boiler installations. Salary in accordance with qualifications and experience ; periodical overseas leave in Great Britain, with passages paid for employee and family ; accommodation provided at low rental ; provident fund and medical insurance benefits.—Applications, with details of experience and references, should be made in the first instance to Dr. T. F. West, 4, Grafton Street, London, W.1.
E7019 A

ASSISTANT WORKS MANAGER. The successful applicant will have had varied experience in light engineering. M.C. shop, press shop and small mechanisms assembly, be a keen disciplinarian and able to control a labour force of several hundred. Only those who possess the initiative, drive and personality to fill this post, which carries a good salary and prospects with pension entitlements, should write, giving full particulars, to Personnel Manager, Ronea, Limited, Romford, Essex.
E6997 A

CHIEF RATE FIXER AND TIME STUDY ENGINEER is required immediately by a medium/heavy engineering company in the North-West of England. The selected applicant must have served a recognised apprenticeship and have had wide experience in a senior capacity in time study and rate fixing applied to general engineering. This is a responsible position with real prospects for the right man. Please supply details in chronological order giving particulars of experience, positions held and present salary.—BOX No. E7012, "The Engineer." A

COMPRESSOR DESIGNER
and
PNEUMATIC TOOL DESIGNER

The Air Power Division of Joy-Sullivan, Limited, Greenock, have vacancies for :

1. A first-class Engineer with experience in design of air and gas compressors, reciprocating and rotary.
2. A first-class Engineer with experience in the design of rock drills and similar pneumatic tools.

Applications are invited from men with at least five years' experience in the design of such machines, and who hold at least Higher National Certificate in Mechanical Engineering. The successful applicants will be required to devote a fair proportion of their time to new development work requiring a high degree of initiative and personal design responsibility, and a good salary will be paid to first-class men.

Please send full particulars to :
The General Manager,
Air Power Division,
Joy-Sullivan, Limited,
Cappielow,
GREENOCK, Renfrewshire.

E7027 A

APPLICATIONS ARE INVITED from PROJECT ENGINEERS over 28 years of age and having H.N.C. minimum qualification for a vacancy in the Production Engineering and Development Department at Ferodo Limited. This is a senior staff appointment and candidates must have had experience in one or more of the following subjects : Production Engineering and Plant Layouts, Factory Mechanical Services Layouts, Special Plant Design. The successful candidate will be responsible for handling projects through initial investigation, preparation of estimates and designs, reports, ordering plant and equipment and arranging for installation and final handing over to the works.—Write, giving details of age, qualifications, previous experience and salary required, to the Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E7051 A

APPLICATIONS INVITED FOR THE POSITION OF MANAGER of Installation and Service Department of well-known Engineering Company. Applicants must have had experience of organising site erection of machinery, steam, water and other service piping. Must be good organisers and able to control labour. A knowledge of refrigerating machinery and systems would be advantageous. Preference will be given to candidates not exceeding 45 years of age. Consideration will be given to applications from men who have served in Assistant Managerial capacity. Pension scheme with life assurance. Apply, giving details of experience, age and salary required.—BOX No. E7043, "The Engineer." A

ASSISTANT ENGINEER with Higher National Certificate. Age 26–30. Drawing-office, food processing plant, refrigeration and electrical engineering experience desirable. Applicants must be prepared to travel throughout United Kingdom.—Apply to Personnel Officer, Mac Fisheries Limited, 10/12, Little Trinity Lane, London, E.C.4. E7042 A

DESIGN ENGINEERS H.N.C. (MIN) required. Experience in one or more of the following essential: Cranes, Excavators, Truck Mounted Mobile Cranes and Contractors Plant. Good staff conditions. Pension scheme. Application in writing, all relevant particulars and approximate salary required to:—Personnel Manager, RUSTON-BUCYRUS LTD., Excavator Works, Lincoln. E6960

DESIGNER DRAUGHTSMEN
AND ESTIMATORS

A Progressive and Expanding firm of Engineers in East Anglia seeks the services of two Designer Draughtsmen (age 28–36) for work in connection with construction equipment, special crane type structures, hoisting machinery (steam, diesel, electric). Minimum qualification is H.N.C. or equivalent, one appointment being for a Graduate or Associate Member Inst.Mech.E. Candidates must have sound design experience, with ability to accept responsibility for projects from inception and to produce designs for estimating purposes quickly.

Salaries from £900 to £1200 are envisaged for these permanent posts. There is a contributory pension scheme.

The Company also have vacancies for ESTIMATORS with previous experience in estimating for General Engineering and preference will be given to applicants with previous Drawing-Office and Works training. Age 25–30.

Write in confidence, giving full information about qualifications and experience, quoting Ref. No. G.5970, to :

WRIGHT ATKINSON LIMITED,
Employment Consultants,
70, Queen Victoria Street,
London, E.C.4.

E7066 A

DESIGN ENGINEER.—An Engineer is required by Imperial Smelting Processes, Ltd., to participate in the design and development of furnaces and ancillary plant for the Imperial Smelting blast furnace process for the simultaneous smelting of zinc and lead. Applications are invited from qualified mechanical engineers preferably possessing a good University Degree, together with sound experience, including design, in the heavier type of engineering. Applicants should be under 36 years of age, and must be prepared to travel abroad if required.—Write for application form to Personnel Manager, Imperial Smelting Corporation, Ltd., St. Andrew's Road, Avonmouth, Bristol, quoting reference DE/TE.
E6992 A

DOWTY FUEL SYSTEMS, LTD., OF CHELTENHAM, REQUIRE A
CONTROL PROJECT ENGINEER

The successful applicant will take charge of a section formulating basic design principles of gas turbine fuel systems for aero and commercial use, and the work will include direction of an analogue computing service. Applicants should be of B.S.C. standard with previous experience in similar work. The appointment will carry senior staff status.

Write to :
PERSONNEL MANAGER,
DOWTY FUEL SYSTEMS, LTD.,
ARLE COURT,
CHELTENHAM.

E7023 A

DRAUGHTSMAN, Process Plant Layout and Development, also general factory work, required for Engineering Department.—Apply in writing, giving full details, to Chief Engineer, The Airscrew Co. and Jicwood, Ltd., Weybridge, Surrey. E2501 A

ELECTRICAL SALES ENGINEERS

Bruce Peebles and Co., Ltd., East Pilton, Edinburgh, 5, require ENGINEERS of H.N.C. Standard for their Transformer Sales and Contracts Department. 5-day week. Staff pension and bonus schemes. Housing assistance given if necessary.—Apply, giving details of experience, to Divisional Director (Transformers) at the above address.

E7060 A

ENERGETIC TECHNICIAN WITH SELLING ABILITY required to develop a new READY MIXED CONCRETE business being started on the South Coast by a well established Company. Car provided and company flat available. Salary according to experience. Write stating full particulars of age, qualifications and experience to Box No. E2486, "The Engineer".

ENGINEER, experienced dust collection problems, capable handling schemes from inquiry to completion.—Write, stating experience, age, salary required, The Visco Engineering Co., Ltd., Stafford Road, Croydon. E7015 A

ENGINEER, experienced modern air-conditioning and ventilating plant. Able to handle complete schemes from inquiry to completion on own initiative.—Write, stating age, qualifications, salary required, to The Visco Engineering Co., Ltd., Stafford Road, Croydon. E7016 A

ENGINEERING DESIGN-DRAUGHTSMEN required for progressive and expanding company, experienced in either of the following :—

(a) Mechanical engineering for colliery equipment and mining machinery.
(b) Hydraulic and pneumatic power units for colliery equipment and mining machinery.
(c) Fabricated chemical plant, pressure vessels and heat exchangers.
(d) Structural engineering.

Permanent and progressive appointments for right applicants.

Apply, W. G. ALLEN AND SONS (TIPTON), LTD., Princes End, Tipton, Staffs. E6999 A

EDWARDS HIGH VACUUM LIMITED, Manor Royal, Crawley, Sussex, have the following vacancy for staff in their Research Laboratories. (1) CHEMICAL ENGINEERS to investigate the distillation of thermo-labile substances and to work on pumping, trapping and condensing problems in vacuum chemical systems. Applicants should hold a Degree in Chemical Engineering or equivalent. The commencing salary will be according to age and experience. Both Pensions and Bonus Schemes are operated. Housing available if from London area.—Write, giving full details, to the Personnel Manager. E7077 A

ENGINEERING DRAUGHTSMAN (MECH:) H.N.C. Standard required to act as Supervisor of Apprentice training in drawing office of large excavator manufacturers. Knowledge of Cranes, Excavators or Contractors Plant helpful but not absolutely essential if possessing genuine interest in young persons. Good staff conditions. Pension Scheme. Application in writing, all relevant particulars and approximate salary required to; Personnel Manager, RUSTON-BUCYRUS LTD., Excavator Works, Lincoln. E6959

ENGINEER
required by
THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ORFORDNESS, SUFFOLK

to be a member of a team engaged on the engineering design of special missile telemetry equipment to meet difficult environmental conditions.

The work will include supervision of the preparation of drawings, the preparation of specifications and liaison with design offices, both in A.W.R.E. and industry.

A recognised engineering apprenticeship is required and Corporate Membership of a Senior Engineering Institution or equivalent qualifications.

Some drawing-office experience and up-to-date knowledge of components and material specifications an advantage. Experience in the design of airborne radar and electronic equipment, and particularly of the design problems associated with difficult environmental conditions, is desirable.

SALARY : £845 (at age 25) to £1150 (at age 34 or over) to £1315.

Contributory superannuation scheme. A house or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance. An assisted travel scheme is in operation from Ipswich, Felixstowe and Woodbridge.

POSTCARDS for application forms to the Senior Recruitment Officer at A.W.R.E., Aldermaston, Berks. Please quote ref. B.2040/25.

E7003 A

ENGINEER required with exempting qualifications for Corporate Membership of the Institutions of Mechanical Engineers/Electrical Engineers, to undertake the duties of an ASSISTANT MAINTENANCE ENGINEER in a highly mechanised tube works. The post is progressive and can best be filled by a young man, age 27/30, who has had previous experience in the control of labour engaged in plant repair and preventive maintenance.—Applications, stating salary expected, should be made to the Works Director, Tubes Limited, Eagle Works, Kirby Muxloe, Leicester. E7052 A

ENGINEER SURVEYOR required for inspection of boiler and pressure plant. Must have First Class M.O.T. Certificate with Steam Endorsement or equivalent. Commencing salary £800. Non-contributory pension and other benefits. Resident Shrewsbury or North Shropshire.—Apply, Eng. Dept., General Assurance Corporation, Ltd., 99, Aldwych, London, W.C.2. E7001 A

ESTIMATOR required for London Office of Major Petroleum Distribution Company engaged on the construction of storage installations involving civil engineering, building work, and pipelines. Applicants should have had experience of work on projects of this type. Starting salary commensurate with qualifications and experience. Excellent pension scheme. Apply giving full details of age, qualifications and experience to Box No. E6922, "The Engineer".

EXPERIENCED QUALIFIED MECHANICAL ENGINEER wanted to fill the position of WORKS ENGINEER in rapidly expanding processing factory in the Hull Area. The Works Engineer will be responsible for all engineering matters, including maintenance, re-organisation of Plant and erection of New Plant. He will be expected to actively participate in development work connected with new processes.—BOX No. E7069, "The Engineer." A

HAWKER SIDDELEY GROUP
Industrial Division

ELECTRICAL ENGINEER to handle technical and commercial sides of variety of heavy power contracts. Knowledge of H.V. Switchgear and of Generating Plant advantageous. Possibility of work on Cross Channel D.C. transmission.

I.E.E. membership or comparable qualifications necessary. Preferably under 30.—Apply, stating age, experience, present salary, to Fuller Electric Limited, Fulbourne Road, London, E.17. E7004 A

HONOURS GRADUATES IN ENGINEERING AND SCIENCE required by The Production Engineering Research Association of Great Britain for fundamental research on machine tools and manufacturing techniques. Excellent working conditions and prospects. Good commencing salary with annual increments on merit. Superannuation under F.S.S.U. Applications to the Secretary (R.572), PERA, Melton Mowbray, Leicestershire. E6969

IRRIGATION ENGINEER—COLONIAL DEVELOPMENT CORPORATION requires the services of an Assistant Drainage and Irrigation Engineer, for work on a large irrigation project in Africa. Duties may include investigation and report on other proposed irrigation schemes. Candidates, between 30 and 40 years of age, should be Associate Members of the Institution of Civil Engineers and have practical experience of survey, design and operation of engineering works for the control and distribution of water for irrigation projects.—Full personal particulars, with details of qualifications and experience, to Personnel Officer, 33, Hill Street, London, W.1, quoting Serial 375. E7034 A

JUNIOR TECHNICAL SALES ENGINEER for Transformer Sales Department. Work mainly concerned with on-load tap changers with particular reference to operation control circuits.—Apply, giving details of qualifications, experience and present salary to Personnel Officer, Fuller Electric, Ltd., Fulbourne Road, London, E.17. E7059 A

MECHANICAL ENGINEERING DRAUGHTSMAN required by John Smith's Tadcaster Brewery Co. Ltd., The Brewery, Tadcaster, Yorkshire. Age 25/35, of good general education, and of H.N.C. or higher standard, and sound practical apprenticeship in a modern engineering works. At least two years Drawing Office experience essential, preferably on food, chemical or allied plant, pipe work, pumps, vessels, and steam utilisation. Applicants must be able to pass medical examination, and be of active and energetic character. Good starting salary with annual increments if satisfactory. Voluntary pension scheme in operation, canteen and sports facilities. Reply to Chief Engineer, stating age and qualifications, education, apprenticeship and positions held, in chronological order. Expenses will be paid to those selected for interview. E2496

MECHANICAL ENGINEER

Large London Printing Works with an extensive development programme has a vacancy for a Mechanical Engineer, preferably with experience of printing machinery. A young, qualified Engineer would be considered for this managerial position. Experience in the handling of labour. Excellent opportunity and prospects. Write, stating age, qualifications, experience and salary required, in confidence.—BOX No. E6998, "The Engineer." A

MECHANICAL ENGINEERS

(two posts) required by N.C.B.'s Central Engineering Establishment at Stanhope Bretby, Nr. Burton-on-Trent, in the Tunnelling Branch, to lead sections undertaking development work in connection with an experimental tunnelling machine and its ancillary equipment. Applicants should have a wide experience of engineering practice, including the development of new equipment. Experience of the design, testing and development of rock cutting tools, or in the design and operation of underground machinery, conveyors and mechanical handling or earth moving equipment, would be an advantage, as would experience of the technical direction of, and liaison with, outside contractors. Applicants should have a Degree in Engineering or Corporate Membership of one of the Senior Institutions, with a sound, practical training and experience. Appointment superannuable, and salary according to qualifications and experience within £1250–£1850.—Write, with full details, to Staff Department (X 1425/3/C), National Coal Board, Hobart House, London, S.W.1, before 24th August, 1959. E7013 A

MECHANICAL ENGINEER with some electrical knowledge required to join a group engaged on design and Site Supervision of oil products pipeline and distribution depots in Iran. Knowledge of petroleum practice is essential. Applicants should be aged about 35 years and have design experience of pumping and ancillary equipment. Applicant will be required to work in London in the first instance.—Send fullest particulars to Staff Office, Rendel, Palmer and Tritton, Consulting Engineers, 125, Victoria Street, London, S.W.1. E7050 A

MUNICIPAL MUTUAL INSURANCE LIMITED has vacancies for MECHANICAL ENGINEER SURVEYORS in London, Birmingham and Manchester. Posts are pensionable and permanent to satisfactory candidates, who should have served an apprenticeship and have sound, practical and theoretical knowledge. Technical qualifications : First Class Ministry of Transport Certificate. Also CRANE AND LIFTING TACKLE SURVEYOR with Higher National Certificate for London. Salary, £800, rising to £1100 per annum.—Apply in own handwriting, marking the envelope "Application Engineer Surveyor" and "Private and Confidential," to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E7041 A

PIPE WORK DRAUGHTSMAN (30—40) with H.N.C. or equivalent required by the BEECHAM GROUP. This is a senior appointment and carries a commensurate salary. Profit Participation and Non-Contributory Pension Schemes in operation. Applications in writing only giving full details of age, qualifications and experience and quoting reference PDW 37 to be forwarded to the Personnel Controller, Beecham Group Ltd., Beecham House, Great West Road, Brentford, Middlesex. E6989

SALES ENGINEER required for London Office of rotary printing machine manufacturers. Applicants must have good technical, practical and, preferably also, selling experience of rotaries, and be capable of analysing printers' requirements and promoting sales of new types of machinery. Preferably 30/40 years of age, and possess technical qualification comparable to A.M.I.M.E. A progressive opportunity and a pensionable post. Reply, stating age, chronological details of experience and salary required, to Managing Director.—BOX No. E7028, "The Engineer." A

SITUATIONS VACANT

SENIOR DETAIL DRAUGHTSMAN, O.N.C. (MIN) required. Experience in one or more of the following essential: Cranes, Excavators, Truck Mounted Mobile Cranes and Contractors Plant. Good staff conditions. Pension Scheme. Applications in writing, all relevant particulars and approximate salary required to: Personnel Manager, Ruston-Bucyrus Ltd., Excavator Works Lincoln.
E6961

SENIOR MECHANICAL DESIGN ENGINEER

An Engineer is required with a degree or equivalent qualifications, who will be expected in general to work alongside people engaged in materials research. His function will be the design of specialised materials and apparatus, the construction of mechanical and electro-mechanical devices, laboratory scale plant and neo-mechanisms.

This is an interesting appointment with good prospects with a Research Unit in a pleasant part of the Midlands.

Apply Box No. E6988, "The Engineer".

SENIOR PRODUCTION ENGINEER required for large engineering works in Glasgow, to take control of Production Engineering Department. Fully experienced in manufacturing methods and ratefixing covering machining, fitting, fabricating, and welding, as applied to medium/heavy engineering products. Must have held previous similar position. This is a senior staff appointment, providing scope for promotion. Higher National Certificate in Production Engineering or equivalent.—Apply to (PD) BOX No. E7063, "The Engineer." A

SMITHS MOTOR ACCESSORY DIVISION.— A vacancy exists in London for an ASSISTANT CHIEF INSPECTOR who should be between 38 and 48 years of age and trained as a craftsman and subsequently to the minimum standard of H.N.C. in Mechanical Engineering. Applicants should have an up-to-date knowledge of gauge design and tool-making, and preferably have been associated with large-scale production of component manufacture, including die-castings and small pressings, and with assembly of small mechanisms. They should have had experience in the organisation and control of an Inspection Department. They should also have a thorough theoretical and practical experience in modern Inspection Methods, including the application of Statistical Sampling Procedure. They will be expected to make reports lucidly, both verbally and in writing, and to combine tact with firmness and decision. First-class conditions are offered, together with a salary commensurate with age, ability and experience. Applicants with the required qualifications should write in confidence to : The Staff Manager, S. SMITH & SONS (ENGLAND), LTD., Cricklewood Works, N.W.2. Please quote ref. SM/220. E6994 A

STRUCTURAL ENGINEERS, Senior and Junior, required for busy London office handling wide variety of building schemes. Considerable scope for advancement available to men of initiative. Consideration given to holiday arrangements.—BOX No. E7067, "The Engineer." A

THE GENERAL ELECTRIC COMPANY LIMITED

ATOMIC ENERGY DIVISION ENGINEERS

Vacancies exist in the Design and Contracts Departments at Erith for Engineers to co-ordinate civil, mechanical and electrical layout aspects of Nuclear Power Stations.

Minimum qualification required is H.N.C. or equivalent. Applicants should have a good general engineering background covering a wide field rather than a detailed knowledge of any one branch. Experience of Civil Engineering practice would be particularly advantageous.

Write for application form in the first instance to :—

The Personnel Manager (CON/PL), The General Electric Company Limited, Erith, Kent. E7007 A

THE GENERAL ELECTRIC COMPANY LTD.

has the following vacancies in the Osram Lamp Division, North Wembley, and at Shaw, Nr. Oldham, Lancs.

(a) DESIGN ENGINEERS AND DESIGNER DRAUGHTSMAN

To join group engaged in the design of special purpose machinery and fine mechanisms for mass production of light engineering products. The work is interesting, gives scope for initiative and has excellent prospects. Applicants should have a minimum of H.N.C. Mechanical Engineering, and preferably some experience in mechanical design.

(b) DETAIL DRAUGHTSMAN

This vacancy has arisen on similar type of work. Applicant should have O.N.C. Mechanical Engineering, and preferably Drawing-Office experience.

These appointments are permanent and pensionable for the right applicant. Applications, giving full particulars of experience and qualifications, should be sent to :—

The Personnel Officer,
Osram Lamp Works,
Brook Green, Hammersmith, London, W.6.
E7048 A

WORKS MANAGER to take charge of Medium sized specialist fabrication works. Experience in specialised construction of medium and heavy fabrication essential. Application in writing stating qualifications and experience to Box No. E2485 "The Engineer".

QUASI-ARC, LTD., require a WELDING APPLICATIONS ENGINEER with a degree or equivalent qualification for a responsible position as assistant to the manager of the department engaged on the development of automatic and semi-automatic arc welding processes. Previous experience of automatic welding is not essential but candidates should have a sound basic knowledge of mechanical and electrical engineering and physical metallurgy with at least 3 years' experience in an industrial job having some association with welding. The post offers considerable scope for a young man with original ideas and the ability to progress to higher executive levels. A good starting salary will be paid to a man with the right qualifications and experience.—Apply in writing to Quasi-Arc, Ltd., Team Valley, Gateshead, 11. E2503 A

THE PYRETHRUM BOARD OF KENYA have a vacancy for a PLANT SUPERVISOR/MAINTENANCE ENGINEER to take charge of a small high vacuum distillation plant. Applicants should preferably have served an engineering apprenticeship and have had experience in light engineering. A knowledge of high vacuum equipment and distillation would be an advantage. The initial contract would be for four years' commencing at a salary of £1100 per annum, with participation in the Board's Insurance Schemes. The Board would provide either accommodation at a moderate rental or a housing allowance. Air transport (including family) to and from Kenya would be available. The successful applicant would spend up to 7 months in Britain to gain experience in the operation and maintenance of Plant prior to its shipment to Kenya. The salary during this period would be in the region of £800 per annum.—Applications should be made in writing, giving full details of previous experience, to : The African Pyrethrum Technical Information Centre, Ltd., 4, Grafton Street, London, W.1. E7076 A

THE BRITISH CAST IRON RESEARCH ASSOCIATION requires an INVESTIGATOR to join a team undertaking research on cupola melting. An elaborate, well-instrumented hot-blast cupola on an industrial scale has been provided at the Association's laboratories for this work. This vacancy provides an excellent opportunity for fundamental work in a field of considerable practical importance. Candidates should be of diploma, degree or equivalent standard and should be able to handle physical-chemical and thermal calculations. They need not have had actual experience of cupola operation but they should have an interest in the practical operation of this melting unit. The salary will depend on age, experience and qualifications.—Applications should be sent to the Director, British Cast Iron Research Association, Bordesley Hall, Alvechurch, Near Birmingham. E7073 A

TUBE TRADE (STEEL) WORKS MANAGER required for medium-sized private company in the Birmingham area. Previous experience should cover low and high carbon steels, hot rolling, cold drawing, welded tubes and production control. Vacancy occurs owing to ill-health of present occupant.—Reply briefly in writing when reply form will be sent. Strictest confidence observed.—BOX No. E7070, "The Engineer." A

TURBOCHARGER ENGINEERS required for rapidly expanding department of engine accessory manufacturers. Preferably a Graduate, but experience in diesel development essential, together with the ability to discuss design and application problems and at all levels.—Write, stating age, experience and present position, to the Manager, Turbocharger Department, Holset Engineering Co., Ltd., Turnbridge, Huddersfield. E2500 A

WE WILL PAY TOP SALARIES for first class REINFORCED CONCRETE DESIGNERS AND DETAILERS. Five-day week—Superannuation Scheme.—Applications direct to : MESSRS. HAJNAL AND MYERS, 7, The Park, Golders Green, London, N.W.11. E2502 A

WHESSOE LIMITED
DARLINGTON

require a

DESIGNER

with H.N.C. or degree and D.O. and workshop experience. The job calls for experience of structural work and of designing chemical plant using pressure vessel codes ; it offers plenty of scope for originality and inventiveness.

Apply in detail to The Staff Officer, Whessoe, Ltd., Darlington, quoting this paper and the reference 20/59. This is a re-advertisement.

E7064 A

WORKS METALLURGIST required for large Engineering Works, Glasgow area. Applications accepted from qualified candidates having attained H.N.C. standard in Metallurgy. Thorough background essential in Physical Metallurgy, Chemical Analysis, Radiography and Welding Research. Excellent remuneration and position to selected applicant. Applications, showing full details in chronological order.—Write, 2970, Wm. Porteous and Co., Glasgow. E7002 A

YOUNG ENGINEER required as Technical Officer by Combustion Engineering Association, London. University degree or A.M.I.Mech.E., some experience in industry. Initiative, ability and experience in writing semi-technical articles essential. Write age, experience to Director, The Combustion Engineering Association, 70 Jermyn Street, S.W.1. E2498

YOUNG ENGINEER required for a progressive and expanding company, to carry out experimental investigations into the performance and design of oil-fired heating equipment. Applicants should have a good theoretical knowledge of heat transfer, principles of combustion, air flow, and general physics, and be prepared to devise their own experimental methods, install apparatus and carry out test programmes. Permanent and progressive appointment for right applicant.—Apply, W. G. ALLEN AND SONS (TIPTON), LTD., Princes End, Tipton, Staffs. E7000 A

SITUATIONS VACANT

HEAD WRIGHTSON COLLIERY ENGINEERING LIMITED

a Designer Contractor Subsidiary of Head Wrightson & Co. Ltd.

Specialising in complete plants for the treatment of Coal and Minerals and equipment for Colliery Surface Schemes,

require the services of

A CHIEF DEVELOPMENT ENGINEER

who will be responsible for the Company's Development Department and will be required to work in close association with the Parent Company's Research and Development Division.

Applicants should be approximately 35 years and have at least an Honours Degree in either Mechanical or Chemical Engineering.

also required

A DEVELOPMENT ENGINEER

to work with the above. Applicants should be approximately 27 years, and should preferably have an Honours Degree in either Mechanical or Chemical Engineering.

Written applications, stating age, qualifications, experience and salary range, should be addressed to :—

The General Manager, Ref. C.E/2,
Head Wrightson Colliery Engineering, Limited,
46, Rutland Park, Sheffield, 10.

E7025 A

PROGRESS CO-ORDINATOR

A rapidly expanding large engineering company in the North-West requires a PROGRESS CO-ORDINATOR immediately. Must be a first-class personality, able to command the respect of other executives and have experience in light to medium engineering works progress. The selected applicant will have the responsibility of co-ordinating all the existing progress departments into an efficient organisation and will be given full management backing. A very good salary is offered to the right man. —BOX No. E7024, "The Engineer."

A

TECHNICAL WRITER

Bruce Peebles & Co., Limited, East Pilton, Edinburgh, 5, require a fully experienced Technical Writer. Applicants, age bracket 28–35, should have recognised qualifications in electrical engineering.

The work requires the ability to write lucid descriptions of products and processes covering all aspects of rotating plant, transformers, rectifiers and electronic equipments for publicity, technical press and direct mail. High standards of accuracy and ability to write in clear, concise English are called for. The position will be permanent and staff pension and production bonus schemes are in operation. Assistance with removal expenses and house purchase where necessary.

The man chosen will be under the Publicity Manager, but must be able to work and co-ordinate detailed information without constant supervision.—Send full details of age, education, experience and salary expected to Mr. J. S. Baillie, Publicity Manager, at the above address.

E7039 A

PLANT INSPECTION AND CORROSION ENGINEERS FOR BAHRAIN

APPLICATIONS are invited for the above positions from men not over 35 years of age with a University degree in Metallurgy or Mechanical Engineering and preferably previous experience in related work in the Oil Industry.

The duties comprise the inspection of fired and unfired pressure vessels, pumps, heat exchangers, pipe-lines, valves, &c., in service in a modern oil refinery to ascertain their condition and to render reports recommending replacement, adoption of preventive measures and/or new materials necessary to enable the plant to operate continuously in an economical and safe manner.

Salary in accordance with qualifications and experience, with air-conditioned housing provided and an allowance to cover normal meal costs. Kit allowance, free medical attention, paid local and home leaves, pension scheme.

Apply in writing giving full particulars and quoting " INS " to :

CALTEX SERVICES, LIMITED,
CALTEX HOUSE,
KNIGHTSBRIDGE GREEN,
LONDON, S.W.1.

E7049 A

Classified Advts. continued on page 106

SITUATIONS VACANT

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH AND DEVELOPMENT DEPARTMENT

APPLICATIONS BRANCH ENGINEERING SECTION

Applications are invited for the following vacancies at new laboratories located in the South of England.

(a) CIVIL ENGINEERS

CIVIL ENGINEERS with at least two years' design and construction experience are invited to join a team which is being formed to carry out **advanced design studies** on **large-scale development projects** in the **nuclear field.** The work will expand in the near future to include the construction of some of these projects.

Experience in the **design and layout of power stations** or other similar heavy industrial plant would be an advantage. For one of the vacancies preference will be given to candidates with experience in the design of **pre-stressed concrete.**

Applicants should have qualifications leading to corporate membership of one of the senior engineering institutions and preferably have an honours degree.

(b) Recent GRADUATES or others with less qualifications or experience are also required to assist in the above work.

(c) MECHANICAL ENGINEERS

Well qualified MECHANICAL ENGINEERS are invited to apply to join a group concerned in the development of **heat exchangers** for **nuclear power stations.**

Candidates should preferably have an honours degree and a good knowledge of **heat transfer and steam cycle calculations.** Previous experience in research and development would be an advantage.

The work will entail the **conception, development and testing of prototype heat exchangers.** In order to carry out this work, a new experimental facility is in the course of design. The successful candidates will, therefore, have the opportunity of starting at the beginning of this interesting project.

(d) ENGINEER OR PHYSICIST

An ENGINEER or PHYSICIST is required to take charge of a small team dealing with problems arising during investigations into **hydraulic, pneumatic and fluidised transport of coal.** The field of study covers a wide range including the **fluid dynamics of pipeline flow,** the **drying of coal slurries** and the **production of micronised coal.**
Candidates should possess an honours degree in mechanical engineering or physics and have at least two years' experience in research and development.

(e) MECHANICAL ENGINEER

An experienced MECHANICAL ENGINEER is required to assist in the design, construction and running of experimental plant concerned with the above **pipeline studies.** A knowledge of pumping equipment and coal handling plant would be an advantage.

Applicants must have a minimum qualification of H.N.C. with several years' experience in the handling of experimental machinery.

(f) DESIGNERS

A design office is being set up to undertake the design of a wide variety of experimental projects. Vacancies exist mainly for **mechanical and civil engineering designers** but some exist also for **electrical and electronic design engineers.**

Applicants should have energy and imagination, preferably be of at least H.N.C. standard, and have had several years' design or drawing office experience.

Previous work on the design of experimental equipment would be advantageous.

Salaries for the posts which are superannuated, will initially be on scales within the overall range £570–£1775 p.a. according to age, duties and responsibilities. Promotion prospects to a higher range for first class men within this new and expanding organisation are very good. We are facing a number of new and challenging problems and every encouragement will be given for staff at all levels to make the maximum contribution to their successful solution.

Application form obtainable from the Personnel Officer, 24–30, Holborn, London, E.C.1, should be completed and returned by 28th August. Envelopes should be marked "Confidential Ref. ENR/311."

Further information if required may be obtained by ringing CHAncery 2866, Ext. 134.

E 7044 A

SITUATIONS VACANT

STEELWORKS TECHNICAL SUPERINTENDENT

required for

DURGAPUR

HINDUSTAN STEEL LTD., INDIA

The above Company requires immediately for their new Steelworks at present under construction by ISCON at Durgapur, West Bengal, a General Superintendent (Works) to take charge of the entire production and technical administration of the whole Steelworks plant.

Applicants should preferably be not below 40 years and not over 60 years of age, and should have had considerable previous experience in a similar position in a large modern Steelworks.

The Company is prepared to offer a two to three years' Contract (with option to renew) with usual tax concessions in India applicable to technicians. Free passages out and return for self and family, free house and car.

The exact salary to be paid will depend on qualifications and experience.

The successful applicant will be required to leave for India to take up his appointment as early as possible.

Applications to be submitted in triplicate (in guaranteed strictest confidence), stating age, nationality, details of education and practical training, subsequent appointments (names of firms, periods of employment, salary and position held), professional and/or technical qualifications, if any, health conditions, marital status, when available, the salary expected, and contact telephone number, quoting reference DSA/101, to : Appointments Manager, Room 614, The International Construction Co., Ltd., 56, Kingsway, London, W.C.2, not later than 21st August, 1959.

E7055 A

ATOMIC ENERGY ESTABLISHMENT, WINFRITH, DORSET.

An experienced INSTRUMENT ENGINEER is required for the Works Services Group to be responsible to a Senior Engineer for the efficient running of an Instrument Services Organisation engaged on the maintenance, calibration and testing of industrial type electrical, mechanical and electronic instruments, including plant instrumentation connected with the Site services of a large research Organisation.

Applicants should have served a recognised Engineering Apprenticeship or have had equivalent training. They should be Corporate Members of a Senior Professional Institution and have had experience in the electro-mechanical instrument field. Experience in the calibration and testing of industrial instrumentation and a sound knowledge of the maintenance of electronic and conventional instruments is essential.

Salary : £1345 to £1800 p.a.

Housing, Superannuation Scheme, generous leave allowance, good working conditions.

Send Postcard for application form and details to :
Personnel Branch (W.135/25), U.K.A.E.A., A.E.E., Winfrith, Dorchester, Dorset, not later than 4th September, 1959.

E7008 A

THE REED PAPER GROUP

Reed PAPER GROUP

is expanding the Packaging Division Development Department and has vacancies for Engineers on the development of package manufacturing processes.

SENIOR GRADUATE MECHANICAL ENGINEER:

This is a Senior appointment with the Development Section ; aged about 35 to 45 ; experienced in the development of advanced special purpose machines with a high degree of automatic control; must have proven administrative ability to direct and co-ordinate the efforts of the Engineers who will be responsible to him ; preferably with background experience of paper conversion processes. **Reference MW/ERM/ES.1**

GRADUATE INSTRUMENTATION ENGINEER:

This is a Senior appointment with the Process Development Section ; aged about 30 to 40 ; responsible for the development and design of control and recording equipment for paper conversion processes ; must have a sound practical experience on the design and application of electrical, hydraulic, pneumatic and electronic devices to automatic process control. **Reference MW/ERM/EI**

EXPERIENCED GRADUATE MECHANICAL ENGINEER:

This is an engineering appointment in the Process Development Section ; aged about 30 to 40 ; must have proven ability in line production machine development and design involving automatic handling techniques associated with light components. **Reference MW/ERM/EH.**

All these appointments are tenable at New Hythe, Nr. Maidstone, Kent. Salary will be commensurate with the qualifications and experience required. Excellent conditions of service include non-contributory pension scheme and assistance with house purchase.

Write for application form to :
Packaging Division Development Department,
The Reed Paper Group, Larkfield, Maidstone, Kent,
quoting the appropriate reference.

E7035 A

Mars LIMITED

offers a first class opportunity for a

DEVELOPMENT ENGINEER

to work in the Chief Engineer's Department at its

Head Office in Slough.

This appointment, which carries an unusual amount of authority, calls for an ability to apply a wide and advanced theoretical training to practical problems, to design and commission special purpose equipment which will result in the further reduction of manual operations in an already advanced plant. A good honours degree in mechanical engineering is essential, combined with a flair for practical application and keen observation. Candidates should have a proved record of original work and the ability to handle problems decisively and swiftly.

The age range for the post is 28–35 years and the commencing salary will be in the range £2200–£2500 per annum, with excellent prospects for considerable advancement on these figures. The post also carries outstanding non-contributory Pension, Life Assurance and Sickness Benefits.

Applications, stating age, experience and qualifications, should be addressed to the

Chief Personnel Officer,
Mars Ltd., Dundee Road, Slough.

E7026 A

SITUATIONS VACANT

DESIGN ENGINEER

An old established Engineering Company in the West of Scotland, specialising in general and hydraulic engineering, invites applications from men over 30 years of age for a senior appointment on their Design staff.

This appointment carries responsibility for the conception and development of irrigation and hydro-electric gate work. The job demands a high degree of technical ability and engineering experience, combined with a flair for original design. A knowledge of up-to-date fabrication methods would be an advantage.

A salary commensurate with ability and experience will be paid for the post ; a contributory pension and life assurance scheme is in operation.

All applications, with details of experience and salary expected, should be sent to the Managing Director, Glenfield & Kennedy, Ltd., Kilmarnock, and will be treated in the strictest confidence.

E7046 A

SITUATIONS VACANT

A CHARTERED ELECTRICAL ENGINEER

required by

W. H. ALLEN SONS & Co., LTD.
Queens Engineering Works, Bedford

To undertake commercial work involving the preparation of tenders for a.c. and d.c. machines, control gear and switchgear, for marine and industrial applications, including water undertakings.

Some experience as outside representative desirable.

Preferred age range 30–40 years.

Applications in writing to : the Personnel Manager.

E7053 A

SITUATIONS VACANT

DRAWING OFFICE MANAGER

required for Works employing over thirty draughtsmen who are concerned with several million pounds worth of engineering plant and equipment.

QUALIFICATIONS University Degree in Mechanical Engineering desirable.
Corporate Membership of the Institution of Mechanical Engineers essential.

EXPERIENCE Design and layout of buildings and heavy industrial plant, together with their associated equipment.

Applications giving full details of age, qualifications and experience should be sent to the Personnel Officer (Staff),

PILKINGTON BROTHERS LIMITED
St. Helens, Lancashire

E7018 A

OLD-ESTABLISHED GOLD MINING COMPANY OPERATING IN GHANA INVITES APPLICATIONS FOR THE FOLLOWING APPOINTMENTS :—

CHIEF ENGINEER
ELECTRICAL ENGINEER

CHIEF ENGINEER

This position entails responsibility for the whole of the mechanical and electrical equipment on the surface and underground, comprising treatment plant, 15 M.W. oil-engined power station, large and small winders, pumps, ventilation fans, air compressors, drilling equipment, mechanical loaders, battery and oil engine-operated locomotives and transport fleet. Candidates should be members of one of the recognised professional engineering institutions, preferably with B.Sc.(Eng.). Considerable experience and knowledge of the running and maintenance of similar installations is essential. Age 40 to 45, in good health, and with ability to organise and control large engineering staff. Salary will be commensurate with experience and qualifications, starting at not less than £2250 per annum.

ELECTRICAL ENGINEER

The Electrical Engineer is responsible to the Chief Engineer for the maintenance of all electrical plant and machinery on the surface and underground and for the installation of all new electrical equipment. He should have experience in power generation and distribution and be methodical in maintaining records and ordering spares. Previous mining engineering experience essential ; technical qualifications at least up to H.N.C. (Electrical) standard. Salary commensurate with experience and qualifications, starting at not less than £1500 per annum.

Tours are of 15 months' duration, followed by 3 months' leave on full pay with passage paid ; marriage allowance of £180 per annum or free passage for wife each tour ; non-contributory pension scheme ; furnished quarters, medical attention, electricity and laundry provided free. Ghana income tax rates.

These posts will give an interesting and rewarding career with a prosperous company to men of energy and ability.

Applications, which will be treated in confidence, should give details of technical training, practical experience and positions held, and be addressed to BOX No. E7045, " The Engineer."

A

NORRIS CONSULTANTS LTD.,

in view of a two-year expansion programme, require for their London and Bristol Offices and elsewhere in the U.K., Senior and Junior Engineers, Designers and Draughtsmen in the following fields.

CIVIL ENGINEERING DIVISION

Reinforced Concrete, Heating, Ventilating, Air Conditioning, Refrigeration, Pipework and General Services, Structural Steelwork.

PRODUCTION & MECHANICAL DIVISION

Special purpose machines, Transfer Systems, Jigs and Tools, General mechanical, Mechanical Handling, Electrical (Heavy and Light current).

Salary scales up to high level in accordance with age, experience, technical and professional qualifications. Pension and Insurance schemes. Write or telephone Head Office, Beacon House, Queens Road, Clifton, Bristol, Tel. : Bristol 3-6817, or those requiring appointments in London Area, write or telephone: 76, Victoria Street, S.W.1. Tel. : VIC 4675.

E7020 A

ENGINEERS

are required to lead or work as Members of teams engaged on Research, Design and Development of mechanical and electro-mechanical equipment of a unique and unorthodox nature.

The work covers a wide field including laboratory instruments, design of special equipment and acceptance testing of associated equipment. Equipment to be designed entails use of special materials and requires unusual design techniques.

A recognised engineering apprenticeship is required with several years' experience of design work and Corporate Membership of a Senior Engineering Institute.

The appointments are at various levels depending on ability and experience.

Salary : Will be assessed within the range £845–£1800.

Contributory Superannuation Scheme. A house or alternatively substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

Postcards for application forms to the Senior Recruitment Officer at Atomic Weapons Research Establishment, Aldermaston, Berks. Please quote ref. B.2099/25.

E6991 A

SENIOR PRODUCTION ENGINEER

The Glacier Metal Co., Ltd., Kilmarnock, leading manufacturers of Plain Bearings, require a Senior Production Engineer for one of their production units.

Applications are invited from qualified and experienced engineers, aged 28 – 35 +, capable of initiating, directing and controlling a wide range of production engineering activities.

An Engineering Degree and/or membership of I.Mech.E. or I.Prod.E. are preferred qualifications and extensive experience of light precision engineering, particularly machining and press tool work is essential. A starting salary scale of £1150–£1350 per annum is envisaged, but for exceptional ability or experience this range might be extended. Excellent opportunities exist for further advancement.

Applications, containing brief details of qualifications, experience and present salary, to Personnel Manager, Glacier Metal Co., Ltd., Kilmarnock.

E7022 A

SITUATIONS WANTED

EXPORT EXECUTIVE (44), Engineering Degree, A.M.I.E.E., Specialist Power Generation, Transmission and Distribution ; Steam and C.I., Allied Machinery. Fluent Spanish and Portuguese. Many years resident Latin American Countries. Accustomed dealing at top level, including Government Departments. Now free to join suitable Export Organisation. Write.—BOX No. E2489, " The Engineer." B

BUSINESSES and PREMISES

PRECISION ENGINEERING BUSINESS situate at Monmouthshire. Modern two-storey factory on lease. Floor space 22,520 sq. ft. Price £30,000 s.a.v.

General sheet metal and light engineering business, North London. Freehold factory premises, 7500 sq. ft., plus ancillary buildings. Turnover £50,000–£60,000. Price £75,000 all at.

Further particulars of Henry Butcher and Co., 73, Chancery Lane, W.C.2. Tel.: HOL 8411.

E7040 L

BUSINESSES and PREMISES

INDUSTRIAL ACCOMMODATION Light Engineering Storage 5000 super with Office Block and 8000 super. All services including Private road, Car Park, near Great South West Road. Reasonable rental.—Macks Structures (London), Ltd. Feltham 5761. E2504 L

AGENCIES

AGENTS: Nationally known firm of engineers seek agents for Heavy Pressings and Forgings in London, West Country, South Wales, Liverpool, Newcastle and Glasgow, with well-established connections in engineering industries, Box No. E2497, "The Engineer".

FOR HIRE

BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone : SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 K

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E125 MW

Classified Advts. continued on page 108

SUB-CONTRACTING

FACTORY EXTENSIONS

WILSON PIPE FITTINGS LIMITED are pleased to announce that their factory extensions have been completed and capacity is now available for high quality grey iron castings up to 30 cwt individual weight. Our foundries are backed by modern engineering workshops and we offer both pattern-making and machining facilities. Prices competitive and deliveries realistic. Technical Staff will call on invitation.
Enquiries to Mr. J. S. Hanna, Bridgeton Foundry, Glasgow, S.E. (Tel.: BRIDGETON 4381-5).

E6924 MW

PATENTS

THE PROPRIETORS of British Patent No. 749,637 for "IMPROVEMENTS IN AND RELATING TO GAS AND VAPOUR COMPRESSORS," desire to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E7058 H

SNUBBERS FOR CRANE BOOMS. The Proprietors of British Patent No. 721801 will grant Licences or will sell the entire British Patent Rights —Replies to Bromhead and Co., Chartered Patent Agents, 19–23, Ludgate Hill, London, E.C.4. E7071 H

MACHINERY Etc. WANTED

REQUIRED.—Good Condition Lansing Bagnall Model SFR225 Stand-on Reach Fork Truck, preferably 10ft. lift.—Offers and full details to: B. & F. Carter and Co., Ltd., Albion Works, Bolton. E2499 F

MISCELLANEOUS

TIME RECORDERS. Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157–159, Borough High Street, London, S.E.1. E110

FOR SALE

TWO TAYLOR & CHALLEN NO. 6 GDP. DOUBLE SIDED DOUBLE ACTION TOGGLE DRAWING PRESSES for sale. Arranged motor drive 400/440/3/50 and fitted with automatic operator's guard. One machine has punch stroke 24in. and blankholder stroke 12in., the other machine has punch stroke 16in. and blankholder stroke 9½in., 38in. between uprights.—Full details, &c., from F. J. Edwards, Ltd., 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E7032 G

VALES PLANT REGISTER LIMITED

OFFER FOR IMMEDIATE SALE

CRANES

NEALS 1-ton "D" MOBILE, 30ft. Lattice, Ruston engine, pneumatics, 1950. £750.
JONES "Super 20" MOBILE, 16ft. Jib, Petrol, Solids. £275.
JONES "Super 22" MOBILE, 18ft. Cantilever Jib, Pneumatics. £500.
NEALS "NM" 2-ton MOBILE, 35ft. Jib, Ruston engine, Pneumatics. £1450.
COLES 2½-ton EMA MOBILE, 16ft. Jib, Perkins engine, Pneumatics. £1050.
BUTTERS 3-ton Electric DERRICKS, 120ft. Jibs, S.LI's. £1500 each.
MORGAN 5-ton Electric DERRICK, 120ft. Jib. £1450.
COLES THORNEYCROFT 5-ton LORRY MOUNTED, 30ft. Jib, Rope, Derricking. £2500.
COLES 6-ton MOBILE, 19ft. Jib, Pelapone engine, Pneumatics, New 1950. £2500.
BUTTERS 7-ton 2-motor Electric DERRICK, 120ft. Jib. £2975.
MORGAN 7-ton Electric DERRICK, 100ft. Jib, New 1943, good condition. £1200.
RUSHWORTH 7-ton Hand Derricks, 30ft. Lattice Jibs. £245 each.
MICHIGAN TMCT 16 7½-ton LORRY MOUNTED Crowd Shovel, Dragline and 30ft. Jib, Buda Diesel, Pneumatics. £3300.
ANDERSON 10-ton Electric DERRICK, 120ft. Jib, new 1945, good condition. £3850.
COLES 12½-ton FULLY MOBILE, 80ft. Jib. £4750.
FOR A COMPREHENSIVE LIST OF PLANT FOR SALE AND HIRE—SEND FOR VALES FREE PLANT REGISTER.
Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone: VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

FOR SALE

Edwards

TAYLOR & CHALLEN No. 562 Double-Sided Geared Power Press, balance drive, complete with automatic press guard, arranged motor drive for 400/440/3/50, pressure exerted approximately 100 tons, stroke 2in., between uprights 24in., tee-slotted bed 22in. by 20½in., weight approximately 71 cwt.
New Type SKG.203 size Motorised Geared Open-Ended Guillotine Shearing Machine, Undercrank type, arranged motor drive for 400/440/3/50, capacity mild steel 80½in. by ¼in., length of blades 83½in., depth of gap in open ends 6in., treadle-operated clutch, weight approximately 40 cwt.
NEW MUBEA All-Steel Construction Bar and Angle Shear, flywheel and gears are situated inside the body, which gives a clean appearance to the machine and also protection to the moving parts, arranged motor drive for 400/3/50, Model KSF100, round bars 2in., square bars 2in., flat iron 10in. by ¾in., 5¼in. by 1in., angles up to 4in. by ¼in., 5in. by 0·425in., tee iron 5in., beams 6in., channels 6in., approximate weight 4400 lb.
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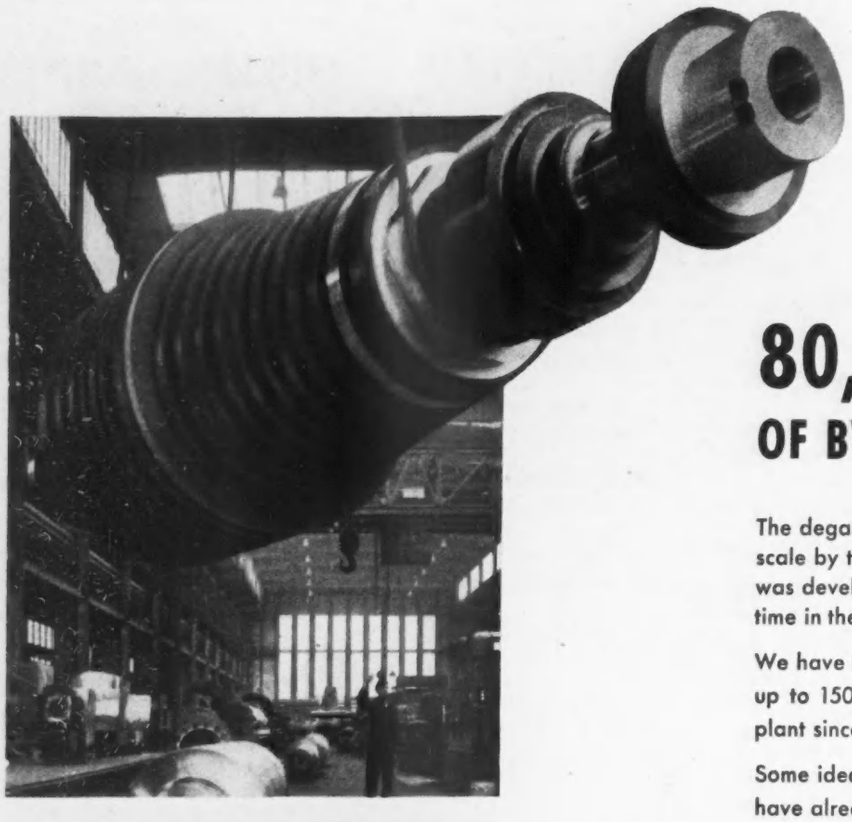

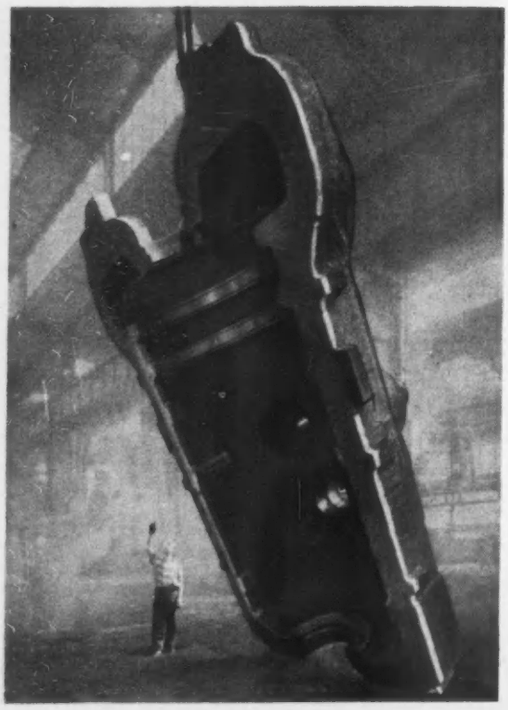

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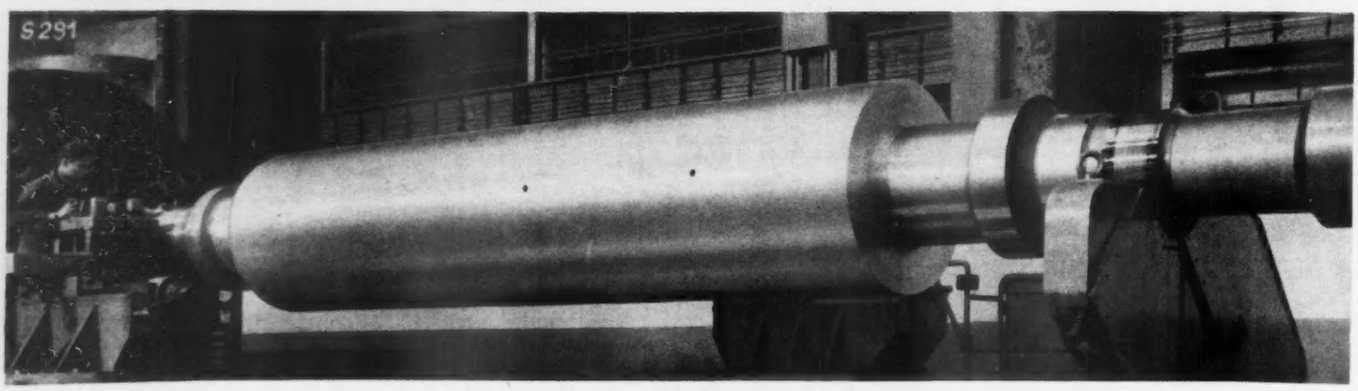

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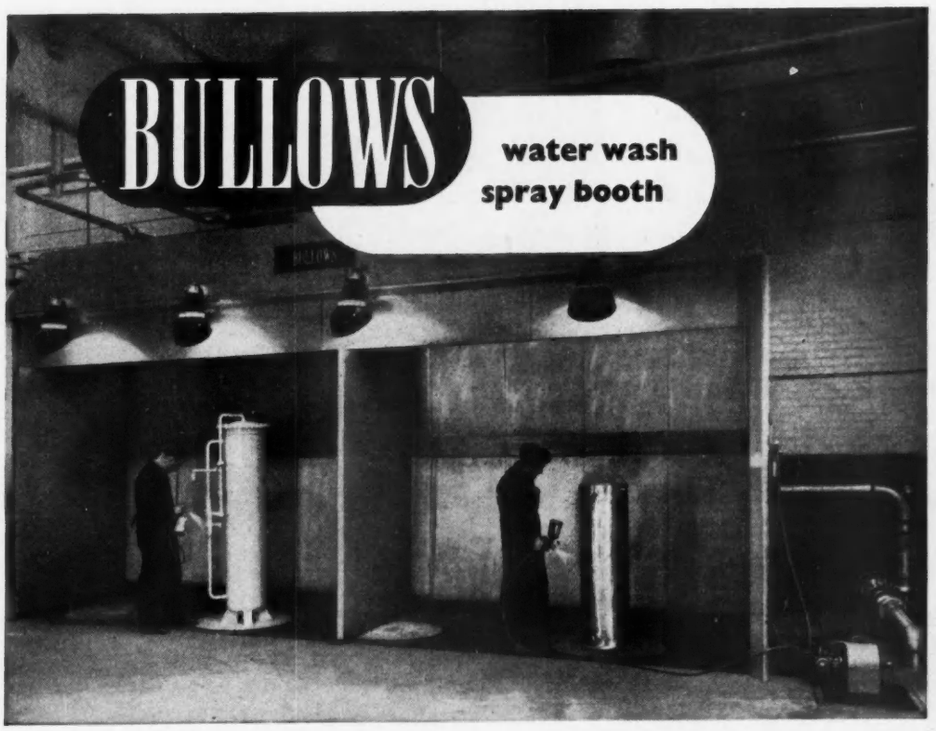

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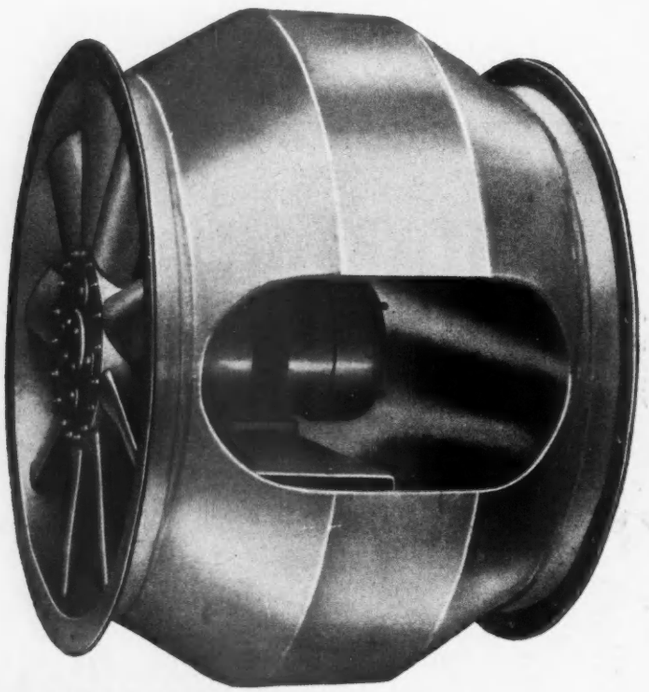

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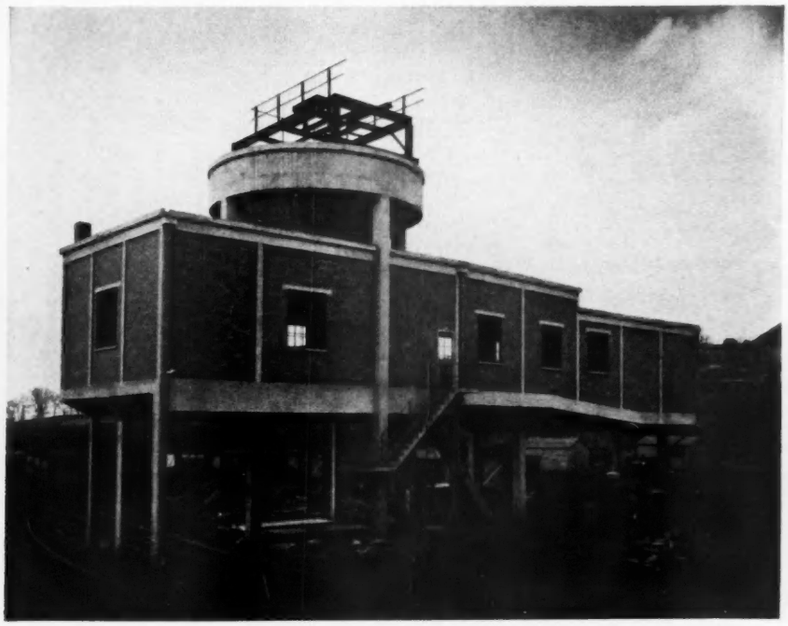

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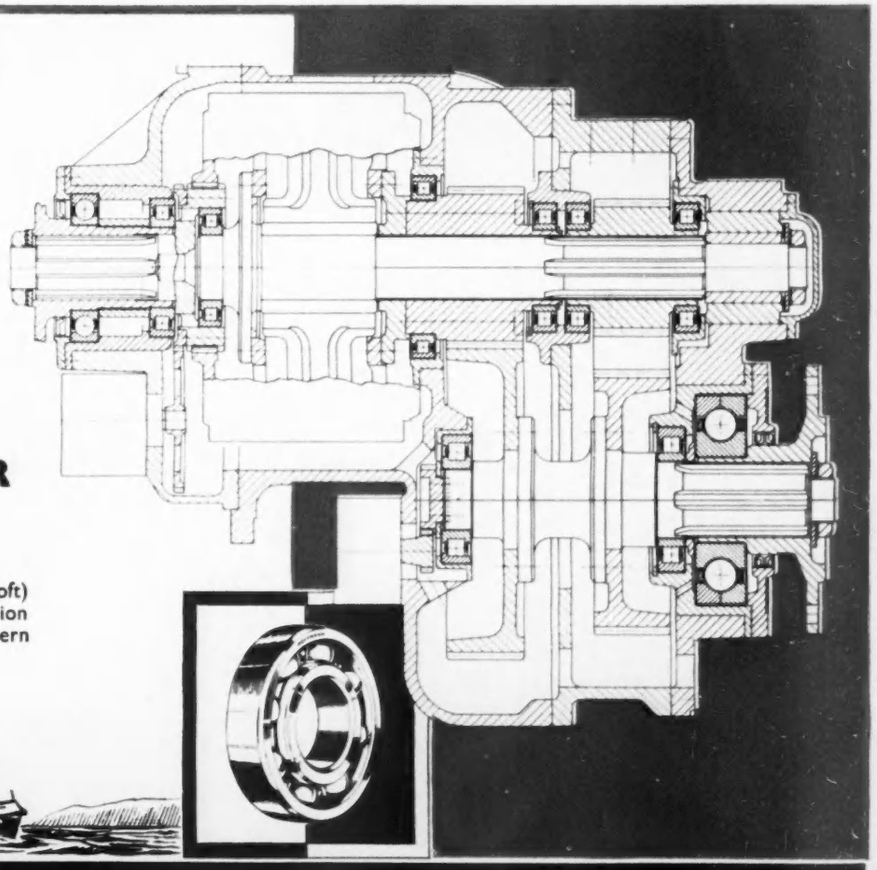

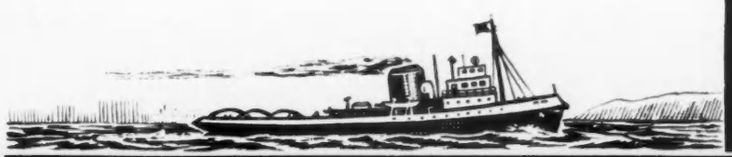

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